HOWS AND WHYS
of COOKING

HALLIDAY AND NOBLE

Esther T. Long.

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HOWS AND WHYS OF COOKING

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HOWS AND WHYS OF COOKING

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FOREWORD

The discussions and directions for cooking contained in this book represent the practical findings of several years of experimental work on cooking carried out in the cooking and chemistry-of-food laboratories of the Department of Home Economics of the University of Chicago.

The purpose throughout has been to find out how to prepare really good food—the best possible according to our standards—and to put into words the essentials of each cooking process down to the smallest details, if such contributed toward success. On the other hand, we have tried to weed out all the non-essential details which have crept into certain methods of cooking. That we have set ourselves rather a large order, too large to be carried out to a final conclusion for many products, will be realized by those who have struggled through the study of permutations and combinations in college algebra. The ordinary plain cake, for example, would have to be made some thousands of times before all the possibilities of order and combination were exhausted. We have in such a cake six major ingredients—fat, sugar, egg, flour, baking powder, and liquid—all of which can be varied as to proportion and kind, and also as to order and method of combining. Furthermore, temperature, humidity, and the personal factor introduce yet another series of variables. Hence it is that this cake recipe and many others probably still contain irrelevant details. We hope, however, that we have included the relevant ones and that our description of each process involved is such that it can be carried out with a fair degree of success at the first trial by any intelligent person, no matter how little her previous experience in cooking. We trust to the pictures and the explanations to make complete success ultimately possible.

We may add that while the explanations given here are the best we have to offer at the moment of writing, they of necessity leave much unsaid. Cooking processes are really most compli-

cated and involve a knowledge of chemistry, both organic and physical; physics; botany; bacteriology; and, indeed, some phase or other of practically all the natural sciences. As a consequence, complete and fully adequate explanations will come only after much more experimental work has been done by those trained in many sciences.

Evelyn G. Halliday
Isabel T. Noble

University of Chicago
April 2, 1928

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CHAPTER I

VEGETABLES

Raw vegetables, with their bright green, yellow, red, and white colors, are so good looking that many an enterprising grocer helps to sell his stock by making a pleasing window display of it. Such vegetables as are eaten raw reach the table still looking attractive—lettuce and radishes are even used as garnishes—but such as are cooked all too frequently lose every vestige of their original beauty during the process. At the same time, the good taste disappears and they become flat and insipid, or, worse still, strong and unpleasant with an odor to match.

Cabbage, a vegetable especially rich in vitamins and one that is cheap and readily available a large part of the year, is almost universally ruined in cooking. When raw it is a creamy white, with perhaps a tinge of green. It has a pleasing leafy structure and a slightly biting flavor of which most people are quite fond, as is evidenced by the favor in which this vegetable is held for coleslaw and as a salad ingredient. When cooked, it may well be as delicate and pleasing as when raw. Instead it usually is changed completely and has a very strong taste; a disagreeable odor which penetrates to the furthermost corners of the house, where it tends to linger; and a most unappetizing dirty-brown color. So universally is this true that cabbage has acquired a very bad reputation and is seldom, if ever, served at the best eating-places. Indeed, a preference for it is taken as evidence of a most plebian taste of the Jiggs and Dinty Moore variety.

The pictures used as a frontispiece tell more plainly than words the disastrous effects of poor cooking on one member of the cabbage family, Brussels sprouts. For these pictures, two samples of similar appearance were chosen. One of these was dropped into a large amount of rapidly boiling water and cooked only until tender; the other was overcooked by methods which will be discussed later, but which would seem to be the prevailing

ones, judging from the fact that the brown sprouts look more familiar than the green. Unfortunately we cannot here reproduce the taste and odor of the two samples, but they were quite as different as is the appearance. The green one tasted and smelled like the raw, save that it was a little milder; the brown one smelled like a concentrated essence of the odor which has given cabbage its bad name, and it tasted just as it smelled.

It is our purpose to discuss the cooking of vegetables from three angles, the preservation of color, of flavor, and of nutrients. Sometimes one and the same method answers all purposes, but not always. In some instances we have to sacrifice one or another; but not all three, as is so frequently done.

PRESERVATION OF COLOR IN COOKING VEGETABLES

Vegetable colors fall into four groups—green, red, yellow, and creamy white—all of which are distinct chemical compounds of unlike properties. As a consequence, no general rule can be laid down for their preservation; each pigment must be considered by itself.

GREEN VEGETABLES

Chlorophyll, the coloring matter of green vegetables, is almost insoluble in water, as everyone knows who has noticed how little color there is in the cooking-water poured off such vegetables. Loss of green color during cooking is therefore not due to solution in the cooking-water but rather to a decomposition of the coloring substance.

As a matter of fact, the green pigment is very readily destroyed by cooking conditions. Heat and acid are its enemies; and both have a chance to do their work when vegetables are long cooked, particularly in small amounts of water in covered vessels, or, worse still, in a steamer or pressure cooker.

The acid which causes the trouble in cooking, surprising as it may seem, comes from the vegetable itself. One may well ask why this acid does not bring about the destruction of the chlorophyll in the raw vegetable as well as in the cooked. The answer is that in the raw state the tissues may be thought of as being made up of tiny compartments, the acid being in one set and the

chlorophyll, along with certain salts which hold it in colloidal solution, in another set which the botanist calls "plastids." When vegetables are cooked, however, both acid and chlorophyll tend to run out of their respective compartments and come together. Therefore, if we do not provide means of diluting or neutralizing the acid, the chlorophyll is bound to be destroyed.

Good evidence that chlorophyll changes location is shown by the fact that green vegetables become much greener soon after they are put into hot water. Probably what happens is that the water dissolves out some of the salts in contact with the chlorophyll and the heat coagulates some of the proteins, which causes a general upset of conditions within the plastids. After this, the chlorophyll diffuses into the outer waxy covering where it is more plainly visible; hence the intensification of the color. Since the chlorophyll is not water-soluble, it stays right there; and our cooked vegetable will be vividly green if we can prevent acids, along with heat, from decomposing it.

Some comparative data on the rate of change caused by heat and acid were obtained recently in our laboratory. For this work, solutions of chlorophyll isolated[1] from spinach leaves were used. Portions of these were dropped into solutions[2] of different reaction —acid, neutral, and alkaline—and the time noted at which color changes occurred at different temperatures. A few of the findings are given in Table I. The alkaline solution reported here had a reaction approximately that of Chicago city water; whereas the reaction of the acid one is comparable to that of certain other waters *after vegetables have been cooked in them*, or to that of the liquid which condenses around steamed vegetables.

It will be observed that decomposition at the higher temperature of 90°–92° C. was much more rapid than at the lower one of 22°–24° C. Thus we see that in the slightly alkaline solutions

[1] E. B. Hart, H. Steenbock, C. A. Elvehjem, and J. Waddell, "Iron in Nutrition," *Journal of Biological Chemistry*, LXV (1925), 67.

[2] For this study, Clark and Lubs's buffer solutions ranging from a pH value of 1.2 to 9.4 were used; also, dilute solutions of hydrochloric acid and sodium hydroxide covering the same range of hydrogen-ion concentration as the buffer solutions. The rate of change was found to vary with the solution used, also with the solvent for the chlorophyll, but was always in the same *order* as that reported in Table I.

the color persisted 48 hours in the cold solution as against 50 minutes in the hot one. At boiling temperature or higher, as in a pressure cooker, the decomposition would undoubtedly have been still speedier than it was at 92° C.

The effect of a little acid or alkali is also seen to be very marked, for at room temperature the color began to fade in 30 minutes in the faintly acid solution, whereas it persisted 48 hours in the faintly alkaline one.

Actual cooking-experiments bear out the findings of this study. Vegetables, like spinach, which can be cooked in a very

TABLE I*

RATE OF DECOMPOSITION OF CHLOROPHYLL IN FAINTLY ACID, APPROXIMATELY NEUTRAL, AND FAINTLY ALKALINE SOLUTIONS

(Acetone Used as a Solvent for the Chlorophyll)

Reaction of Solution	Temperature	Length of Time Color Remained Good
Slightly acid (pH 5.4)	22°–24° C.	30 minutes
Approximately neutral (pH 7.2)	22°–24° C.	2 hours
Slightly alkaline (pH 8.2)	22°–24° C.	48 hours
Slightly acid (pH 5.4)	90°–92° C.	2 minutes
Approximately neutral (pH 6.8)	90°–92° C.	8 minutes
Slightly alkaline (pH 8.2)	90°–92° C.	50 minutes

* Experimental work by Callie M. Coons.

few minutes will remain green even in neutral or faintly acid solution; while those requiring half an hour or so, such as string beans, are bound to lose their color[1] unless the cooking-water is kept slightly alkaline. Furthermore, even a slightly alkaline cooking-water will not preserve the color if the time of cooking is prolonged for an hour or more.

If the water used is comparable in alkalinity to that of Chicago city water, no difficulty will be experienced in keeping it

[1] Just for interest it may be stated that soluble compounds of copper and zinc will stabilize and intensify the color of chlorophyll even in acid solution. Some of our grandmothers turned this fact to account and kept their pickles green by making them in copper kettles. Apparently the copper, dissolved from the kettle, repaired the damage caused by the acid as fast as it was incurred.

alkaline throughout the cooking-period. Just how waters throughout the country do compare with that of Chicago is not known. A little study[1] made here recently, however, gives us some reason to think that alkaline waters are rather common.

For this study, 47 samples of water were collected—44 from home economics laboratories in 40 different states; 3 from other sources. Of these, 39 were appreciably alkaline (pH 8) when received, or were made so by boiling for a little while. This was true for "soft" mountain waters as well as for "hard" ones, which may be a bit surprising to some of us who are accustomed to think of alkaline waters as those that contain compounds of calcium and magnesium which separate out as a curd when soap is used, thus giving us visible evidence that the water is "hard."

In order to keep the water on the alkaline side during cooking, one should use rather a large proportion of water to vegetable, and leave the cooking-vessel uncovered, particularly during the first few minutes of cooking. The point in leaving the kettle uncovered for the first few minutes of cooking is to allow the volatile acids, which are evolved in greatest abundance at that time, to pass off in the steam. The value of a large proportion of water is to furnish alkali to neutralize the vegetable acids as they come off with enough to spare to maintain a slight alkalinity in the solution. If we use a small amount of cooking-water—more especially water with no free alkali to dispose of the acid, as would be the case if we used neutral water[2]—we may well reach a concentration of acid in the cooking-water which is quite sufficient to accelerate materially the decomposition of the chlorophyll. In cases where neutral water must be used, we shall, if we want to preserve the color, have to add a speck of soda, not more than one-sixteenth of a teaspoon per quart of water, for all green vegetables except spinach and other tender greens. These cook very quickly—in other words, before heat and a little acid have time to do much damage. Any appreciable excess of soda is to be avoided, not because of its effect on the color, for it will intensify that, but be-

[1] Data collected by Brenta MacGregor.

[2] Distilled or rain water, or water obtained by melting snow or ice, is usually approximately neutral.

cause it will make the vegetable soft and slimy, a most unpleasant condition, and because it will tend to destroy vitamins.

If we use a steamer or a pressure cooker, conditions are even worse than when we boil in neutral water. In both cases most of the volatile acids are retained; and these, together with the non-volatile ones, are enough to bring the acid concentration of the little bit of water which condenses on the vegetable to the danger point for color. In the pressure cooker we have the added disadvantage of very high temperature, which of itself is sufficient to cause decomposition of the chlorophyll.

For all methods of cooking, the importance of shortening the time can hardly be overemphasized. Various devices can be employed for doing this. Thus, by having the water really boiling when vegetables are put into it and by keeping it boiling throughout the cooking-period, considerable time is saved. Removing the stems from spinach just about cuts the cooking-time in two. This is not so impractical a performance as one might imagine. It really takes little, if any, longer to prepare spinach for cooking without the stems than with them, for the time lost in snipping off the stems is just about made up in the shorter time required to wash the stemless leaves. As far as the food value is concerned, discarding the stems probably makes but little difference. For one thing, it is doubtful whether the food value of the stems is very high. This assumption is based on some comparative iron tests made[1] here recently, in which the stems were found to have little better than a third the iron content of the leaves. Furthermore, such loss in nutritive value as may be occasioned by removing the stems is probably compensated for by the shorter cooking-period. As we shall point out later, short cooking preserves nutrients as well as green color.

In cooking asparagus, the tips are usually cooked much longer than necessary in order to make the butts tender. A good way to get around this difficulty is to cook the asparagus standing upright in a vessel provided with a lid, the center of which has been cut out by a tinner, thus allowing the tips to be kept out of the water while the butts are being cooked. When the latter are fairly

[1] Experimental work done by Margaret Abt.

tender, the lid may be removed and the bundles of asparagus laid flat. An additional 5 to 10 minutes cooking will be all that is necessary to cook the tips.

Summarizing, then, our conclusions regarding the cooking of green vegetables in such a way as to preserve their color, we find we should drop them into rapidly boiling water and cook them uncovered for the shortest possible time. There should, moreover, be considerably more water used than that absolutely required to cook them, unless, like spinach, they can be cooked in a very short time, say 4 to 5 minutes. The approximate volume of water to use is given in the directions for cooking vegetables.

Another point to be emphasized is that, in general, green vegetables cannot be cooked in a steamer or a pressure cooker without loss of color. Spinach forms an exception to this general rule and can be cooked in a steamer without appreciable loss of color. Obviously there is no object in cooking spinach in a pressure cooker, since this method is of advantage only for vegetables which require long cooking.

YELLOW VEGETABLES

The coloring matter of bright-yellow vegetables such as carrots, squash, and sweet potatoes belongs to a class of pigments called "carotinoids." Surprisingly enough, these carotinoids are also invariably present along with chlorophyll in green vegetables on the average in the proportion of 3.5 parts of chlorophyll to 1 part of the carotinoids. Under normal conditions the yellow is entirely masked by the green and it is only when the latter disappears that the yellow shows up. Thus it is that we are not aware of the yellow in the leaves until the autumn, when the chlorophyll disappears. And so it is in cooking green vegetables; if we destroy a large part of the chlorophyll, the little that remains plus the yellow carotinoids gives our cooked vegetables a bronze-green color.

It is interesting to know that the yellow carotinoids of vegetables are the very same pigments which are found in milk fat, and hence in butter; in beef fat; and in egg yolk. The animal body cannot synthesize these pigments; therefore, if none is present in the food, none appears in the body fat, milk, or eggs.

The yellow pigments are almost insoluble in water and are quite stable, being but little, if any, affected by the conditions of cooking. The darkening occasionally seen in the cooking of yellow vegetables is more probably due to the scorching of the sugary juice than to a decomposition of the yellow pigment. As a matter of fact, yellow vegetables can be cooked in a small amount of water, in a steamer, or in a pressure cooker without damaging their color.

RED VEGETABLES

Red vegetables are rare, being limited, chiefly, in this part of the world at least, to radishes, beets, and red cabbage, the last of which might more properly be called purple than red. The coloring matter of these vegetables belongs to a group of pigments called "anthocyanins," which are also responsible for most of the color of red, purple, and blue flowers and fruits.[1] So wide is their distribution in nature that they deserve a little more attention than their limited occurrence in vegetables would warrant.

There appears to be any number of anthocyanins, most of which are soluble in water and give a bright-red color in distinctly acid solution. They differ from each other slightly in their chemical composition and considerably in their color reactions with certain metals and with acid or alkali of different concentrations. For example, if alkali is added gradually to the distinctly acid solution of a water extract of red cabbage, the red color changes first to purple, then to blue, and finally to green, with all possible intermediate shades. Moreover, this whole series of color-changes appears before the neutral point is reached—in other words, while the solution is still slightly acid.[2] Similar color-changes occur upon the addition of tin, aluminum, zinc, and various other metals in soluble form.

The water extract of red beets does not behave like that of red cabbage. When alkali is added gradually, no appreciable color-

[1] The coloring matter of red tomatoes is not an anthocyanin, but a carotinoid called "lycopin." This pigment is an isomer of carotin, the coloring matter of carrots.

[2] According to Clark (*The Determination of Hydrogen Ions* [Baltimore, 1923], p. 94), the color range as a pH value is red 2.4 to 4.5 green.

change occurs until the neutral point is passed and the solution is slightly alkaline. Then the color changes from red to purple and soon begins to fade. Furthermore, metals appear to have no affect on the color.

In general, these color-changes are all reversible within a reasonable time limit. This means that adding acid will undo the work of alkali—of metals also, it happens—and will give back the original red color, provided the time of adding it is not too long delayed. The red form appears to be the stable one; the others are more or less unstable, with a tendency to fade to colorless forms.

Color-changes similar to those just discussed are met with in cooking vegetables and fruits containing anthocyanins. Red cabbage, for example, does not stay red during cooking unless we actually add acid to the cooking-water in the form of vinegar, lemon juice, or even tart apples. Without added acid the color turns purple or blue in neutral cooking-water, green in alkaline waters. The same thing happens in steaming, save that the color-change never goes beyond the blue stage.

At first thought it may seem rather peculiar that the cabbage should turn blue when steamed—a change which indicates a decrease in acidity—for, in steaming, the acidity of the cabbage as a whole cannot have suffered any material change. The compartment idea, already used in connection with green vegetables, will make this clear, particularly if one recalls the fact that red cabbage in the raw state is not uniformly red, but instead has red layers of varying thicknesses superimposed on white ones. Judging by the color-changes in steaming, we might guess that the acidity of the red and white layers is not the same, and that, when the vegetable is cooked, free diffusion of the juices from the red to the white, and vice versa, lowers the acidity of the juice as a whole to the point required for the blue color. That this is true can be shown by grinding up the cabbage and squeezing out the juice, which is blue, not red. The blue color will go back, however, to the original red upon the addition of a little acid.

Many fruits have anthocyanins very similar to the one in red cabbage. This is shown by the color-change which may occur in

cooking or canning such fruits. Certain blue ones—plums, for example—develop a reddish shade when cooked, apparently because the juice of the fruit as a whole is more acid than the original color-bearing part. Red fruits, on the other hand, sometimes turn purple when canned. This change was most puzzling until Culpepper and Caldwell[1] showed that it occurred only when tin containers were used and that it was caused by a reaction between the anthocyanin of the fruit and the tin of the can. This purple color acts just like that produced by alkali, and tends to disappear when acid is added.

In cooking beets, we find, as we might expect from the behavior of their water extract, that the acidity of their own juice is enough to maintain the color. Therefore, so long as we do not pare beets or cut them up, we can cook them in any kind of water without adding extra acid and still have the color good. Besides, we can steam them or cook them in the pressure cooker without loss of color, and by such means preserve flavor and nutrients as well.

Briefly then, the best conditions for cooking red vegetables—and fruits—are just the opposite to those for green. For the red, acids favor color retention; whereas alkalies and certain metals cause undesirable changes, perhaps even complete loss of color.

WHITE VEGETABLES

We are not accustomed to think of white vegetables as containing any color; and it is possible that some of them—Irish potatoes and white onions, for example—do not. A large number of them, however, contain minute amounts of either the yellow carotinoids, which, as we have just seen, are not affected by cooking, or of another class of peculiar pigments not yet mentioned. These are the flavones, pigments which in low concentration are almost, if not quite, colorless, more especially in dilute acid solutions such as are most vegetable juices, but which turn yellow in alkali, and brown or green with iron. Even the little bit of alkali in tap water may be sufficient to give a pronounced

[1] "The Behavior of the Anthocyan Pigments in Canning," *Journal of Agricultural Research,* XXXV, No. 2 (1927), 107–32.

yellow color to vegetables like yellow-skinned onions, which contain an appreciable amount of these pigments. If the vegetable turns yellow, so too will the cooking-water, for the flavones, being easily water-soluble, are largely dissolved in the cooking-water. This yellow color is pleasant rather than otherwise, and consequently there is no objection to its appearance.

There is, however, a disagreeable, and as yet unexplained, color-change which may occur in cooking white vegetables. They turn a brownish gray. This color appears almost invariably on long cooking of all white vegetables, and is decidedly ugly. Although we do not know why it comes, we may hazard the guess that the flavones have something to do with it, perhaps by diffusing until they come in contact with the iron of the vegetable and with it forming the dark compound already mentioned. Or, in the long cooking-process some of the flavones may be changed over to their near relatives, the anthocyanins, in one of the latter's unpleasant dark-colored forms. If such is the case, the addition of a little acid in the form of vinegar or lemon juice will cause a reddening of the vegetables. A color-change of this kind is sometimes observed in long-cooked cabbage when acidified.

There is also the possibility that in long cooking, the iron and sulphur of the vegetable have a chance to get together and form a dark compound.

Whatever the cause, it is certain that white vegetables do not darken unless overcooked. Hence, this unpleasant change may be avoided by cooking such vegetables only until tender. It happens that most of the white ones belong to the cabbage family; therefore, as we shall see presently, by short cooking to prevent darkening we tend also to prevent the development of bad taste and odor.

PRESERVATION OF FLAVOR IN COOKING VEGETABLES

THE CABBAGE FAMILY

The vegetables most apt to change flavor on cooking are those of the cabbage family, which includes Brussels sprouts, cauliflower, and turnips. These vegetables, along with onions, are

sometimes classed as "strong juiced" which is something of a misnomer so far as the cabbage family is concerned, for the vegetables in this group are really not "strong juiced" when raw and do not necessarily become so when cooked. Such vegetables contain sulphur compounds which in their natural state are rather sharp, but withal pleasing in taste and not at all suggestive of what we have in mind when we say "strong." These sulphur compounds, however, are of such a nature that they break up easily under unfavorable conditions of cooking and give as a product of their decomposition substances of disagreeable taste and smell. One of these substances has been found to be hydrogen sulphide, which is also one of the things formed when eggs spoil and is largely responsible for their offensive odor. It may seem, at first thought, that any compound which is capable of yielding anything so unpleasant as hydrogen sulphide must of itself be repulsive; but that such is not the case we can easily see if we think of the possible decomposition products of many mild and pleasant substances. Take common table salt for example; under proper laboratory conditions it can be made to yield sodium, a most active and dangerous element, and chlorine, which was one of the poison gases used during the war. Fortunately, table salt, as every one knows, is a very stable compound and cannot easily be split into its component parts under any conditions, certainly not those of cooking. Some of the sulphur-yielding compounds of vegetables, however, are not stable; instead they readily go to pieces. The way to make this happen in cooking is to cook the vegetables for a long time, particularly in the presence of a little acid, as we do when we cook in a small amount of water. We probably increase the chance of decomposition also by heating very slowly at first, thus giving the plant enzyme which caused the synthesis of the sulphur compounds in the growing vegetable a chance to go into reverse action and decompose them. We do this when we put the vegetable on to cook in tepid water and allow it to heat up very slowly, and when we cook in a steamer. Cooking in a pressure cooker is the worst method of all, for here we retain all the volatile acids evolved from the vegetable, and we have,

besides, a temperature which is high enough to favor decomposition.

If, then, we wish to prevent the development of bad taste and odor in these vegetables (in other words, prevent making them "strong juiced"), we shall take pains to cook them in a large amount of water in an uncovered kettle for the shortest possible time, and we shall not cook them in a steamer or in a pressure cooker.

ONIONS

Onions really are "strong juiced," and they owe their "strength" to volatile constituents already pre-formed in the raw vegetable, of which we are well aware as we wipe away the tears which gather in our eyes as we prepare onions for cooking. They do not behave at all like the cabbage family on cooking, for, instead of developing a new flavor, they simply tend to lose the one they originally had, and on long cooking so much of the flavor may pass off with the steam that the cooked product is flat and insipid. For most people there is a happy medium in the retention of onion flavor, which is brought about by cooking the onions till tender, and no longer, in a rather large proportion of rapidly boiling water. This, by the way, is quite as effective and far less trouble than changing the cooking-water, as is sometimes recommended. If some loss of flavor is desired, onions should not be cooked in a steamer or in a pressure cooker, for in both cases the maximum amount of onion flavor is retained.

OTHER VEGETABLES

In so far as *flavor* is concerned, all vegetables except those of the cabbage family and onions are best cooked by the methods we have just been condemning; that is, in a small amount of water; in the steamer; or, if they require long cooking, in a pressure cooker.

PRESERVATION OF NUTRIENTS IN COOKING VEGETABLES

One may well ask how the scheme of cooking vegetables just discussed will accord with one designed especially to save nutri-

ents. This can be answered best if we consider the three methods of cooking vegetables—baking, steaming, and boiling in water—solely on the basis of their nutrient-saving merits. Judged thus, baking (and by "baking" we mean cooking in the oven without the addition of water) is obviously the best method, for by it nothing is lost. Next comes steaming, again without the addition of water[1] to the vegetables, either in a steamer, where the cooking takes place at the same temperature as in boiling, or in a pressure cooker, where the temperature can be raised to 249.1° Fahrenheit or even higher.

The special advantage of steaming over boiling for preserving nutrients lies in the fact that in steaming the only water which comes in contact with the vegetable is the minute quantity formed by condensation of a little of the steam, a quantity too small to dissolve out nutrients to any appreciable extent. The losses by steaming are, therefore, always considerably less than by boiling. This was well brought out by Peterson and Hoppert,[2] whose report on the losses incurred in cooking vegetables is the most thorough and extensive of any yet published. For the sixteen vegetables used, they found that the average loss in dry matter and crude protein was about 15 per cent by steaming and pressure cooking, 30 per cent by boiling in water to cover the vegetables, and 40 per cent by boiling in double the quantity of water required to cover. Their mineral losses were in the same order as those for dry matter and crude protein, being less for steaming than for boiling.

The work of other investigators agrees with that just cited. So, too, does what we have done in this laboratory, save that ours shows clearly that the losses by boiling need not be so great as those generally reported. This is shown in Table II, where we have compared a few of our findings with those obtained by

[1] To satisfy our curiosity we have compared the losses in soluble carbohydrates sustained by one vegetable—carrots, it happened—cooked surrounded by water in a pressure cooker with those incurred by boiling in an open kettle and have found that the pressure-cooker losses were considerably the larger of the two (experimental work by Margaret Wallace).

[2] "The Loss of Mineral and Other Constituents from Vegetables by Various Methods of Cooking," *Journal of Home Economics*, XVII (1925), 265–79.

Peterson and Hoppert. It will be noted that our losses were appreciably less than theirs in spite of the fact that we used a very large proportion of water, to be exact, six parts of water by weight to one of vegetable, which in itself is conducive to losses, as their report well shows. We attribute our smaller losses to the fact that we used a much shorter cooking-period than did they. Just how much shorter we do not know for certain, because these investigators do not state the exact cooking-period used by them. They

TABLE II

Comparison of Losses in Dry Matter and Protein in Long- and Short-cooked Cabbage and Cauliflower

Vegetable	Experimenter	Weight of Vegetable	Weight of Water	Time of Cooking	Loss in Dry Matter	Loss of Protein, $N\times 6.25$
		grams	grams	minutes	per cent	per cent
Cabbage	Peterson and Hoppert (1)*	400–600	....	30±	48.6	49.3
	Peterson and Hoppert (2)†	400–600	....	30±	60.7	61.5
	Jackson ‡	400	2,400	8	41.3	24.6
Cauliflower	Peterson and Hoppert (1)*	400–600	....	30±	21.8	20.3
	Peterson and Hoppert (2)†	400–600	....	30±	37.6	44.4
	Jackson ‡	400	2,400	9	12.0	9.5

* Boiled in just enough water to cover.

† Boiled in twice the quantity of water needed to cover.

‡ Experiments done by Fannie Jackson in the laboratories of the Department of Home Economics of the University of Chicago.

say that in general the boiling-time of all vegetables was 30 minutes but that the time varied slightly, depending upon how quickly the vegetable became tender. We do not take this "varied slightly" to mean that the time ever dropped as low as 8 or 9 minutes as did ours.

It should be stated that we boiled our vegetables until they were what we called "tender"; but tenderness not being a fixed value, varies, of course, with the person who makes the test. We have become so impressed with the disastrous effects of overcooking the two vegetables used here, cabbage and cauliflower, that we are inclined to call them "done" when they still retain a little of the crispness which most people find agreeable in raw vegetables but apparently not in the cooked ones.

We were also careful to have the water really boiling when the vegetable was dropped into it and to bring the temperature quickly back to boiling—two precautions which undoubtedly helped to shorten the cooking-period, which in turn tended to decrease losses.

Another factor which affects losses in boiling, but which had nothing to do with the experiments just discussed, is the size of pieces into which the vegetable is cut when prepared for cooking. Obviously, when vegetables are boiled in water, the greater the cut surface exposed to the solvent action of the water the greater the losses. The tremendous increase in surface brought about by cutting into small pieces is well illustrated by the time-honored problem of computing the area of a 1-foot cube and of the same cube when cut into 1-inch cubes, this being 864 square inches in the one instance and 10,368 in the other.

Again, the reaction of the water used in boiling, and perhaps also the various mineral elements in it, undoubtedly have some effect on losses. In general, alkali in water appears to work in two opposing ways, tending to increase losses by its action on the tissues and tending to decrease them by shortening the time of cooking. The net effect of these two opposing forces has not yet been worked out.

It appears, then, that we can make no hard and fast rules about losses in boiling, but can simply say that they will always be greater than in baking or steaming and that they are dependent upon the proportion and reaction of the cooking-water, the time of cooking, and the area of cut surface exposed to the water.

There are a number of methods advocated for utilizing the cooking-water. One is to serve it with the vegetable, which is probably equivalent to throwing it away, for it is extremely doubtful if anyone ever eats it. Besides, a vegetable served in a watery bath is not nearly so palatable as one drained and served with a little butter. Another method is to evaporate the cooking-water so that the dissolved nutrients are reabsorbed by the vegetable. In theory this method appears to be just the thing for all vegetables that can be cooked successfully in a small amount of

Courtesy of "Hygeia"

FIG. 1.—Vegetables which can be steamed without damaging either color or flavor. Almost no nutrients are lost when vegetables are cooked by steam.

Courtesy of "Hygeia"

FIG. 2.—Reading from left to right, a pressure cooker, a small, and a large steamer. The pressure cooker is time-saving for vegetables which require long cooking.

water. In practice, however, it is not altogether satisfactory. One objection is that vegetables treated thus have a tendency to discolor; another is the difficulty of evaporating the liquid without scorching the vegetable, because the time when the boiling-down must be done is the busiest period in the meal preparation. But if one can manage it conveniently without deterioration of the vegetable, it is undoubtedly a good practice; so, too, is any other method devised for saving nutrients, provided it does not impair color and flavor.

We have discussed boiling in some detail because it is the method most commonly used and because we think it is the only one to use for vegetables of the cabbage family, for onions, and for most green vegetables. We should, however, like to emphasize the point that we are strongly in favor of steaming all vegetables which can be cooked thus without damaging either color or flavor. A list of such vegetables includes carrots; potatoes, both sweet and Irish; squash of all kinds; wax beans; parsnips; beets; spinach; and other tender greens. A few of these are pictured in Figure 1. Underneath are shown some utensils used in steaming. The large steamer is a convenient size to have, since quite large quantities of several vegetables can be cooked in it at one time. A small family, however, can get along very well with the ordinary household steamer shown in the center of the picture. A pressure cooker, one type of which is shown here, is a great time-saver for vegetables which require long cooking, such as old beets or carrots; but, so far as cooking vegetables is concerned, it is a luxury rather than a necessity.

For the approximate time required to cook vegetables by the different methods and for the proportion of water to use in boiling, see the tables on pages 23 and 24.

In closing this discussion we should like to give one final warning, which is, *cook vegetables only until tender*. This is more important than anything else which can be said. No matter what method we use, no matter what precautions we take, one and all vegetables are utterly ruined by long cooking or, what amounts to the same thing, being kept hot over steam tables a long time after cooking.

DIRECTIONS FOR COOKING AND SEASONING VEGETABLES

The cooking-unit we have chosen is the amount which measures 2 cups when cooked and prepared for seasoning. This measure we call four servings, thus allowing ½ cup for each individual portion. Four servings, however, are not necessarily enough for four people. Indeed, if vegetables are so cooked as to be attractive in color and pleasing in taste, four servings may well be just barely enough for two people.

MEASURE AND WEIGHT OF FOUR-SERVING PORTIONS

In Table III we have given the approximate measure and weight of vegetables as purchased in the city markets and also the weight of the edible portion which yields four servings. Quite obviously the measure and weight as purchased are only approximations and vary with the vegetable itself and with the cook's method of preparing it for the table. For example, the weight of asparagus-as-purchased required for four servings—2 cups when cooked—has been found in this laboratory to be anywhere from 400 to 800 grams. The latter value was for a sample from an early, long-distance shipment and had large, tough stalks, most of which were too woody to cook and therefore had to be discarded. The better sample was home grown and had very tender stalks, nearly all of which could be cooked. In view of the possibility of such marked variations, we have been careful in working out the values for our tables to use a uniform grade of vegetables and *that* the best obtainable in the city markets.

This precaution, however, does not eliminate the variable introduced in the preparation for cooking. Thus, referring again to asparagus, one cook may use only the tips, whereas another may use as much of the stalk as can be made tender on short cooking. We assume the latter practice to be the common, also the desirable one, and therefore have followed it for our tables. We judge the tenderness of the stalks by the way they break, discarding all below the point where a sharp, quick break can be made.

For purposes of economy and for uniformity in reporting results, we have adopted the general policy of eliminating all un-

necessary waste in preparing vegetables for cooking. But even by doing this and by choosing vegetables of the best quality, our measures and weights as purchased show considerable variation. The values given are therefore intended only as a general guide to the inexperienced.

BOILING VEGETABLES

Table IV gives the method of preparation for cooking, the time, the amount of water, and the size of pan used in this laboratory for boiling a four-serving portion of each of the common vegetables. For green vegetables, vegetables of the cabbage family, and onions, we have given the minimum quantity of water (Chicago city water with a pH value of about 8.2 before boiling) required to preserve the color or flavor, or both, as the case may be, when cooked in an uncovered pan of the size mentioned, for the time specified. For other vegetables the amount of water indicated is simply that which we have found necessary in order to cook the vegetable till tender, without boiling dry, in a covered pan. For pans shallower than the ones we use, the amount of water would have to be increased, of course, to allow for more rapid evaporation.

In preparing for cooking, it will be observed, we shred cabbage; separate cauliflower into flowerets; and partially quarter, in other words, slit crosswise at the bud end, onions and Brussels sprouts if old. This in spite of the fact that all increase in cut surface means greater loss in nutritive value. Our reason for cutting is to shorten the cooking-period and thus prevent the development of the bad taste and odor already discussed. In cutting carrots, parsnips, and sweet potatoes into convenient pieces for cooking, we do most of the cutting lengthwise, rather than crosswise, of the fibers, since by the former method less nutrients are lost.

Asparagus may be cooked successfully in either of two ways: It may be stood upright with the tips protruding out of the water, and cooked in this position until the butts begin to be tender—about 15 minutes—then laid flat and cooked 5–10 minutes longer. Or the butts may be cut off and cooked separately

for about 15 minutes, after which the tips may be added and the cooking continued for 5–10 minutes longer.

Red cabbage must have acid present if the color is to remain good. Perhaps the best way to add the acid is by means of tart apples which are pared, sliced, and cooked with the cabbage. Two or three medium-sized apples are required for the 2-cup portion of cabbage. Instead of the apples, 4 or 5 tablespoons of vinegar may be added to the cooking-water.

Although no mention is made of salt in the table for boiling, we do in all cases add it to the cooking-water: 1–1½ teaspoons per quart of water. Whether or not salt increases losses is an open question; there is, in fact, evidence tending to prove both that it does and that it does not. At any rate, cooking with salt helps retain the color of green vegetables, and improves the flavor of all; hence most of us prefer to continue its use.

STEAMING VEGETABLES

Table V gives the time required for steaming most of the vegetables which can be cooked thus without deterioration of color or flavor.

Since losses by steaming are slight, no matter how the vegetable is prepared for cooking, it is advisable to cut all, save beets, into pieces suitable for serving before steaming. Beets form an exception to the general rule and when steamed cut up, acquire an unpleasant shriveled appearance.

SEASONING VEGETABLES

Buttering.—We use 1⅓ tablespoons of butter per 2 cups of cooked vegetable, thus allowing 1 teaspoonful for each individual half-cup serving for all vegetables, save for Irish potatoes, Hubbard squash, and rutabagas, which are mashed. For these we allow 2 tablespoons for each 2 cups of vegetable.

Creaming.—Such vegetables as asparagus, green beans, Brussels sprouts, cabbage—both green and white—carrots, cauliflower, onions, and green peas are very good when served with cream or a rather thin white sauce. For all of these save peas we allow ½ cup of cream or white sauce for the 2-cup portion of vegetable; for peas, ¾ cup. Directions for making white sauce are as follows:

WHITE SAUCE

Yield

One-half cup.

Proportion of ingredients

	WEIGHT IN GRAMS	APPROXIMATE MEASURE
Butter..................	13.1	1 tablespoon
Flour (family or pastry)..	4.7	2 teaspoons
Milk..................	122.0	$\frac{1}{2}$ cup
Salt.........................		$\frac{1}{4}$ teaspoon

Order of work

1. Measure the ingredients.
2. Place the butter in a small saucepan (holding approximately 2 cups); melt it over a low flame; add the flour and salt; stir them with the fat until all are well combined.
3. Remove from the fire; add about 1 tablespoon of the milk; and stir until the mixture is smooth. Then add the rest of the milk slowly, stirring while it is being added.
4. Return to the fire and cook slowly until the sauce comes almost to the boiling-point. The mixture must be stirred constantly to prevent lumping and scorching.

Special methods of seasoning certain vegetables.—(*a*) Candying sweet potatoes: Place cooked potatoes in a shallow pan. Add to them a mixture consisting of $\frac{1}{4}$ cup of light-brown or white sugar and 2 tablespoons of water. (If the potatoes are boiled, the cooking-water may be evaporated to this amount if care is taken to prevent scorching.) Add $1\frac{1}{3}$ to 2 tablespoons of butter. Heat over a low flame or in an oven at 500° Fahrenheit. If candied over a flame, the potatoes will have to be watched constantly and each turned as soon as it has browned. If candied in the oven, the potatoes will have to be looked at only occasionally but will require about 15 minutes for browning.

If extra sirup for pouring over the vegetable is desired, add 2 to 3 tablespoons of water to the sticky mass that remains on the bottom of the pan after the potatoes have been removed, and boil the mixture until it thickens.

b) Browning parsnips: Melt 1⅓ to 2 tablespoons of butter in a frying-pan or other shallow pan. Place cooked parsnips in the butter; heat them over a low flame, or in an oven at 500° F., until they become brown. When heated over a flame, the vegetable will have to be watched constantly and each piece turned as soon as it browns; when heated in an oven, it need be looked at only occasionally, but will require 15 or more minutes for browning.

TABLE III

QUANTITIES OF VEGETABLES AS PURCHASED AND AS EDIBLE PORTION FOR FOUR SERVINGS, APPROXIMATELY TWO CUPS WHEN COOKED

Vegetable	As Purchased			Edible Portion
	Approximate Weight		Approximate Measure	Raw
	ounces	grams		grams
Asparagus	18	500	2½ small bunches	300
Beans, green	10½	300	⅘ quart	255
Beets, with tops (young)	27	750	5 medium sized	370 (cooked)
Beets, without tops (old)	17	480		
Brussels sprouts	10½	300	⅔ of a quart box	240
Cabbage, green (loose head)	27	750	1 medium head (5½ inches in diameter)	450
Cabbage, white (compact head)	9½	270	⅓ medium head (5 inches in diameter)	240
Cabbage, red	11½	320	¾ medium head	265
Carrots, with tops (young)	16	450	11 small carrots	325
Carrots, without tops (old)	14	400		
Cauliflower (as trimmed for the city market)	23	650	1 head (4–5 inches across)	325
Onions, white	18	500	6 medium sized (diameter about 2½ inches)	440
Onions, yellow	19	525	6 medium sized (diameter about 2½ inches)	440
Parsnips (without tops)	14	400	3 medium sized	300
Peas, green	32½	910	2 quarts (shelled, 2½ cups)	350
Potatoes, Irish	12½	350	3 medium sized	300
Potatoes, sweet	13	370	3 medium sized	300
Rutabagas	21	580	⅔ medium sized (about 4 inches in diameter)	535
Spinach, with stems	21½	600	½ peck	570 (wet
Spinach, without stems	32	900	¾ peck	
Squash (Hubbard)	29	800	About ⅙ of a squash about 11 inches in diameter	480
Turnips, white (without tops)	16	450	3 medium sized	340

TABLE IV

Time Table for Boiling Vegetables in Portions* Which Yield Four Servings, Approximately Two Cups When Cooked

Vegetable	How Prepared for Cooking	Approximate Measure of Water to Use		Size of Cooking-Pan		Time to Cook
				Capacity	Top, Inside Diameter	
		cups	cc	quarts	inches	minutes
Asparagus	Woody ends broken off	5	1,200	3	$7\frac{7}{8}$	tips: 5–10; butts: 20–25
Beans, green	Whole	4	1,020	3	$7\frac{7}{8}$	30–35
Beets (young)	Whole	4	1,000	$2\frac{1}{2}$	$7\frac{3}{8}$	40–60
Brussels sprouts	Partially split or whole	5	1,200	3	$7\frac{7}{8}$	9–10
Cabbage, green	Shredded	8	1,900	4	$8\frac{3}{4}$	6–8
Cabbage, white	Shredded	5	1,200	3	$7\frac{7}{8}$	8–9
Cabbage, red	Shredded	$4\frac{1}{2}$	1,050	$2\frac{1}{2}$	$7\frac{3}{8}$	20–25
Carrots	Cut in halves or thirds, lengthwise	3	750	$2\frac{1}{2}$	$7\frac{3}{8}$	young: 20–25; old: 30–40
Cauliflower	Separated into flowerets	$6\frac{1}{2}$	1,600	3	$7\frac{7}{8}$	8–10
Onions, white	Partially quartered	9	2,200	4	$8\frac{3}{4}$	25–35
Onions, yellow	Partially quartered	9	2,200	4	$8\frac{3}{4}$	20–25
Parsnips	Cut crosswise in two pieces and lengthwise in halves or thirds	3	750	$2\frac{1}{2}$	$7\frac{3}{8}$	25–30
Peas	Shelled	3	700	2	$6\frac{5}{8}$	20–30
Potatoes, Irish	Cut in halves lengthwise	4	900	$2\frac{1}{2}$	$7\frac{3}{8}$	25–30
Potatoes, sweet	Cut crosswise in two pieces and lengthwise in halves	3	750	$2\frac{1}{2}$	$7\frac{3}{8}$	15–25
Rutabagas	Cut lengthwise in slices $\frac{1}{2}$-inch thick	9	2,200	4	$8\frac{3}{4}$	25–30
Spinach	Stems not removed	$2\frac{1}{2}$	570	$2\frac{1}{2}$	$7\frac{3}{8}$	with stems: 8–10
	Stems removed	5	1,140	3	$7\frac{7}{8}$	without stems: 4–5
Squash (Hubbard)	Pared, and cut into pieces 2×3 inches	4	960	3	$7\frac{7}{8}$	20
Turnips, white	Pared and cut in $\frac{3}{4}$-inch cubes	8	1,900	4	$8\frac{3}{4}$	20–25

* For quantity to cook see "Edible Portion," Table III.

TABLE V

TIME-TABLE FOR STEAMING VEGETABLES IN PORTIONS* WHICH YIELD FOUR SERVINGS, APPROXIMATELY TWO CUPS WHEN COOKED

VEGETABLE	HOW PREPARED FOR COOKING	TIME TO COOK		
		In Steamer	In Pressure Cooker	
		minutes	minutes	pounds pressure
Beets	Whole	60–90	Young: 15 Old: 30	15 15
Carrots	Sliced crosswise	Young: 25–30 Old: 40–50	Old: 10–15	10
Parsnips	Cut crosswise in two pieces and lengthwise in halves or thirds	35–45		
Potatoes, Irish	Quartered	30–35		
Potatoes, sweet	Cut crosswise in two pieces and lengthwise in halves	25–35		
Spinach (young)	Stems removed	8–10		
Squash (Hubbard)	Pared and cut in 2-inch squares	20–25		

* For quantity to cook see "Edible Portion," Table III.

TABLE VI

TIME-TABLE FOR BAKING VEGETABLES IN PORTIONS WHICH YIELD FOUR SERVINGS, APPROXIMATELY TWO CUPS WHEN COOKED

Vegetable	Approximate Size of Vegetable	Temperature of Oven and Time of Cooking
Potatoes, Irish	Diameter at largest part, $1\frac{1}{2}$–2 inches	450° Fahrenheit for 45–60 minutes
Potatoes, sweet	Diameter at largest part, $2\frac{1}{2}$–3 inches	450° F. for 35–45 minutes
Squash, Hubbard	In pieces $\frac{3}{4}$–1 inches thick	450° F. for 20 minutes, then at 400° F. for 30–40 minutes longer

CHAPTER II

FACTORS WHICH CONTRIBUTE TOWARD SUCCESS IN THE PREPARATION OF MUFFINS, CAKES, BISCUITS, AND PASTRY

Why do many of us find it hard to make two cakes in succession that are equally good? Why do we have trouble if we take half or double the simplest recipe? And why can we seldom, if ever, make an exact copy of a friend's favorite cake with her carefully written recipe right before us?

There are several possible answers, one of them being that we change the proportion of ingredients by our method of measuring, thus evolving an entirely new recipe which as likely as not does not work.

That the proportion of ingredients is a matter of considerable importance is evident enough to anyone who has tried making cakes with either too little or too much flour. With too little flour, the cake froths to the top of the pan, perhaps over the top into the oven, and very likely ends by falling flat. With too much flour, it rises to a peak and, on cutting, turns out to be bready and solid. In no way does either resemble the light, feathery, velvety product we look for in a cake.

The good old-fashioned cook seemingly slaps things together without rhyme or reason, yet usually turns out tiptop products. This is because she has acquired a sense—something which she cannot put into words and pass on—of how things should look and feel. Such a sense, however, is acquired only by long hours on the job, hours which the modern woman with her great variety of interests would prefer to spend elsewhere than in the kitchen. For her, a short cut is essential. She must learn, therefore, to know what factors contribute toward success and how to control them.

PROPORTION OF INGREDIENTS

MEASURING VERSUS WEIGHING

Obviously the first essential is to have the same proportion of ingredients each time we use a given recipe. To do this is simple enough if we weigh our ingredients; but if we measure them, we run into difficulties.

In general these measuring difficulties are of two sorts: those dependent on our manipulation of ingredients and those traceable to our measuring-utensils. These variables are so difficult to control that in home economics laboratories all comparative and research work in batters and doughs has long been done with weighed, rather than measured, ingredients. This, after all, is the safest, surest, and really the easiest way out of the difficulty and is doubtless the way which will be adopted by future generations of women with a scientific training. For such women, weighing presents no difficulties; and the only objection they might be disposed to raise against it is that it takes longer than to measure. This objection, however, cannot be sustained, as anyone can see for herself by comparing the time required for the two processes.

The quickest method of weighing is with spring balances such as those pictured in Figure 3. These weigh 500 grams by 2-gram divisions, which means that they can be used for weighing all materials save those used in very small quantities. To use these, one places the bowl, plate, or whatever is used as a container for the substance to be weighed, on the scale pan at the top, turns the dial until the hand indicates zero, then adds the material in question until the hand points to the required weight. Such balances as these may be obtained from Hanson Brothers Scale Company, Chicago, at a cost of about $10.00.

The Trip scale (Fig. 4) has a capacity of 5,000 grams (about 10 pounds) and a sensitivity of one-tenth of a gram for light loads, and hence has a wide range of usefulness. This scale can be used at a very little greater outlay of time than that required for the spring balances, if one sets aside certain dishes for weighing and provides each with a properly marked counterpoise. Such an arrangement is shown in Figure 4. Here we have on the left

FIG. 3.—A spring balance. All ingredients, except those used in very small quantities, can be weighed easily and quickly on such a balance as this.

FIG. 4.—Trip scale with counterpoised bowl. This balance can be used to weigh both larger and smaller quantities than can the type shown in Figure 3.

side of the balance a bowl of suitable capacity for weighing out flour and sugar, which is balanced with shot placed in the dish labeled "counter-poise for small bowl." With two or three dishes thus counterpoised, weighing can be rapidly carried out simply by placing the required weights on the right side of the balance and adding enough flour, sugar, or whatever is being weighed, to the dish on the left side to bring the balances to equilibrium again. The Trip scale is carried by all scientific laboratory supply houses, such as the Central Scientific Company and E. H. Sargent and Company, both of Chicago. The scale itself costs about $10.00; the weights to go with it anywhere from $4.00 to $10.00 or more, depending on their denomination. A set for weighing 1,000 grams, about 2 pounds, costs approximately $4.00.

Fats and small portions of all dry ingredients are most easily weighed on pieces of paper which can be counterpoised with other pieces of paper of the same kind and size. This is easy enough to manage if one keeps a small pad of glazed paper of suitable size near the balances and, when about to weigh, tears off two sheets, placing one on each of the balance pans. Various other devices for speeding up the process will, of course, occur to the person who undertakes to weigh in place of measure in order to eliminate her first great difficulty, which is to keep her proportions the same each time she uses a recipe.

Much as we favor weighing as against measuring—save for salt, flavoring, and certain other ingredients used in very small proportions—it will be noted that measures as well as weights are given in all our recipes. This is because we realize that, for the present, cooking in American homes is almost invariably done by measure; in Europe, we have been told, weighing is a common practice. Here, even those who teach cooking-courses and have their class work done by weight have a tendency to yield to their early habits and to cook by measure at home. Such being the case, we have given our proportions by measure as well as by weight, hoping thereby to make our recipes usable to those who by choice or necessity still continue to measure.

We must state quite emphatically, however, that if the in-

gredients are measured, the method of procedure must be the same as we have used. Otherwise, these recipes will not give one whit better results than ten thousand others of their kind.

In order to justify our insistence on a certain procedure for measuring, we are giving in the pages that follow a rather full discussion of the facts upon which our conclusions regarding measuring are based.

VARIATION IN MEASURING OWING TO MANIPULATION

Liquids.—Liquids are apparently the easiest to measure, and one might suppose that if half a dozen people were asked to measure a cup of water or milk, using the same cup, that all would measure very nearly the same quantity; but such is not the case. We have observed the measuring operations of some pretty good students, all with considerable scientific training, and have found that there is a general tendency to avoid filling the utensil full of liquid and, conversely, as will be discussed presently, to give extra good measure in solids. Another tendency observed is the failure to empty the utensil completely. If these same students were working with scientific apparatus, they would probably try to be scientifically exact; but cups and spoons have too long been associated with haphazard methods to call for exact work unless the consequences of carelessness are demonstrated.

With careful work, however, which means filling the cup full and emptying it completely, the difference in any number of measurements does not exceed 6 cubic centimeters, which is somewhat less than ½ tablespoonful.

Fats.—In measuring fats, a real difficulty is encountered, and that is the tendency for large air spaces to form, which, of course, is greater if the fat is cold. With what was thought to be fairly careful work, using lard, which is plastic and easily packed, a cupful measured immediately after it was taken from the refrigerator was found to be but 182 grams; whereas the same measure of this lard when allowed to come to the temperature of the room weighed 203 grams, which is the correct value. The difference of 21 grams between the two measurements assumes considerable significance when thought of as almost 2 tablespoons.

Butter, being harder and less plastic than lard, showed an even greater resistance to packing when cold, and a greater tendency to slip and slide around when one tried to pack it down into the utensil.

Another difficulty met with in measuring fats is the resistance to leveling off. If one is not careful, the top is still rounded after passing the spatula over it. A rounded surface would, of course, tend to compensate for air spaces and therefore might appear to be desirable in measuring cold fats, but since no two cups of fat with air spaces and rounded tops are likely to weigh the same, it is better to pack solid and to level off the top to a flat surface.

The difficulty in measuring fats can be much lessened by taking the fat out of the refrigerator for a few minutes in hot weather, an hour or so in cold, before it is to be measured; but even then a special effort must be made to see that the pack is solid with no air spaces.

Flour.—The difficulties met with in measuring fat, however, are as nothing to those in measuring flour. If one really fills an accurate cup with fat and really levels off the surface, one has the correct quantity of that particular fat, with nearly the same degree of accuracy as though it had been weighed. But with flour there is no correct weight for 1 cupful—there is, to be sure, a more or less accepted value[1] which is rather generally used by those who cook by weight, but no absolute, standard one. A cup of the very same flour was, in fact, found to vary in weight from 96 to 134 grams, a difference of over 6 tablespoons, depending on how it was packed.

The thing to do, then, in measuring flour is to find that method of manipulation which will give the best checks and to stick to it one's self and to describe it in detail when giving one's recipes to others.

Two methods of filling a cup were found to give very good checks. One was to sift the flour in small portions and then to fill the cup with a tablespoon, dipping the spoon into the flour gently, bringing it up heaping full, and putting it into the cup with al-

[1] Sybil Woodruff, "Weights of One Cupful of Food Materials," *Journal of Home Economics*, XIV (1922), 270–73.

most as light a touch as though it were an explosive likely to blow up if jarred, then leveling off the top with the *edge* of a spatula—not the flat surface, for with it there is a tendency to use pressure. By this method the variation in the weight of any number of measurements of a given sample of flour need not run much, if any, higher than the equivalent of half a tablespoon per cup.

It may be stated that a cupful of once sifted flour weighs practically the same as a cupful sifted four or five times. There seems, then, no point in sifting it several times, as some of us have been accustomed to do in making angel cake. It is, however, very important that we sift it immediately before using, because flour which has been sifted for some time is very liable to be packed about as solidly as the unsifted. It is also important that the flour be sifted in small portions, not more than 2 or 3 cupfuls at a time. If enough flour is sifted at one time to fill a large bowl or pan, the portion in the lower part of the container will pack down so that a cupful taken from this part will weigh appreciably more than a cupful taken from the upper part.

Another satisfactory method of measuring flour is to sift it directly into the cup, filling the cup slightly overfull and leveling off the surface with the edge of a spatula. We have obtained slightly better checks by this method than by putting the flour into the cup with a spoon. The two methods, however, do not check, the flour sifted into the cup running about the equivalent of a tablespoon less per cup than that put in with a spoon. Thus it is important that in giving our recipes to other people we should tell just how we measured the flour. For convenience we have adopted the method of putting the once sifted flour into the cup with a spoon.

It is impossible, however, to get checks by dipping the cup into the flour or by tapping it to fill air spaces. Once one begins to pack, she does not know where to stop, nor is she likely to stop at the same place twice. Moreover, it would be impossible for her to describe her tapping method in such a way that it could be followed by anyone else.

Granulated sugar.—What has been said about flour applies also to granulated sugar, but not to the same extent. In other

words, this sugar packs, but not so much as flour. The greatest difference in the weight of 1 cupful of a given sugar due to manipulation was found to be a little more than the equivalent of 2 tablespoons per cup as against a difference of 6 tablespoons of flour. The best checks were obtained by measuring sugar by the same method as was used for flour, save that the sugar was not sifted before measuring. By this means, the difference in weight of a number of measurements was equal to about one-fifth of a tablespoon.

Confectioner's sugar.—Confectioner's sugar is usually lumpy; hence it must be rolled and sifted before it can be measured. Like flour, it must be handled carefully to avoid packing. The weight of a given measure is very little more than half that of the same measure of granulated.

Brown sugar.—We have not been able to find any satisfactory method of measuring brown sugar. Our best checks were obtained by rolling the sugar to remove the lumps, then packing it solidly into the cup with a spoon. Measured thus, the weight of a given measure was approximately the same as that of the granulated.

VARIATION IN MEASURING OWING TO UTENSILS

Standards for measuring-utensils.—In the discussion just concluded we have assumed the use of cups of like capacity filled to the brim. The next question is: Are cups of standard capacity available, and, if so, will the manipulation just outlined work in filling the subdivisions?

In order to have all measuring-cups hold the same quantity, a standard has been chosen which is one-fourth of a liquid quart, or 236.6 cubic centimeters. The capacity of a standard tablespoon is one-sixteenth that of 1 cup, of a teaspoon one-third that of a tablespoon. For convenience the capacities of cups and their subdivisions are given in tabular form in Table VII.

Lack of conformity of measuring-utensils with the standard.—To this standard all measuring cups and spoons are supposed to conform; but in reality a large number of them do not, as was shown by an investigation reported in *Good Housekeeping*.[2] For

[2] "Housekeepers Vote for Standard Measures," *Good Housekeeping*, April, 1925, p. 80.

this, "forty-eight different measuring cups—tin, glass, aluminum, and enamelware—were collected from thirty-three manufacturers. These cups were tested at the Bureau of Standards to see

TABLE VII

Capacity of Standard Measuring-Utensils

	Cubic Centimeters or Milliliters
1 cup	236.6
$\frac{3}{4}$ cup	177.4
$\frac{2}{3}$ cup	157.7
$\frac{1}{2}$ cup	118.3
$\frac{1}{3}$ cup	78.9
$\frac{1}{4}$ cup	59.2
1 tablespoon	14.8
1 teaspoon	4.9

how nearly they approached the correct standard for capacity." Concerning these cups the report states:

It was found that half of the cups showed errors from 5 per cent to 25 per cent above or below the standard. The largest cup held almost 50 per cent more than the smallest. The errors in subdivisions, such as half-cups, third-cups, etc., were proportionately greater as the fraction measured grew smaller. Twenty-one of the forty-eight cups tested had the lowest quarter cup division so marked that it held from 10 per cent to 33 per cent too much or too little. The largest of the quarter cups as marked held almost twice as much as the smallest.

It appears, then, that some measuring cups are just about on a par with the good old-fashioned tea cup as an instrument of precision. It behooves us, therefore, to test the ones we have and, if they show glaring inaccuracies, to purchase better ones. A list of the best available can be obtained by writing to *Good Housekeeping*, inclosing a stamped, addressed envelope for a reply.

Fortunately, it is easy enough to determine whether or not the cups we are using are of standard capacity, simply by measuring into them from a graduated cylinder the quantity of water they are supposed to hold. Thus the whole cup should hold 236.6, the half-cup 118.3, cubic centimeters of cold water when filled to the brim in one case, to the graduation mark in the other. Another way to test the capacity is to find out if 4 cups of liquid measured in these cups will just fill a standard 1-quart measure.

If we care to take the trouble, we can also check the accuracy of the subdivisions of any cup in a roundabout way by finding out if two of the half-, three of the third-, and four of the quarter-cup measures of liquid really do fill the whole cup. If two similar cups are not available, the measured portions of liquid can be poured into any utensil and then turned back into the cup being tested; and, if it is just filled and no more, one may conclude that the graduation marks are correctly placed and that they are of suitable width, length, and distinctness. Otherwise, one would not have been able to make the two, three, or four similar measurements required for the check.

Measuring in subdivisions of a cup.—If the graduations of a measuring-cup are distinct and correctly placed and if the cup is made of glass,[1] measurements of fractional cups of liquids can be carried out about as accurately and speedily as of whole cups; but solids are bound to give trouble. Fats, which in small-quantity cooking we so frequently want to measure in quarter- and third-cup portions, are particularly troublesome. It is hard to pack a lump of slippery fat into the bottom of a cup, more especially one with straight sides; and it is still more difficult to level off the top. Not only that, it is time-consuming. So much is this the case that we doubt if small portions of fat are very frequently measured with any degree of accuracy in a cup.

Flour is just about as troublesome to measure in small portions as is fat, chiefly because of the difficulty of leveling off the surface without packing. Moreover, in measuring flour in subdivisions of cups, one has an almost irresistible desire to start tapping the cup to bring the surface of the flour on a level with the graduation. As we have already seen, this is fatal to accurate measurement. And so it appears that we shall have to be much more careful in measuring solids in subdivisions of cups than in whole cups. Little inconsistencies here are particularly troublesome in doubling recipes, such, for example, as one requiring $1\frac{1}{4}$ cups of flour. If we do not use extreme care in measuring, the

[1] If such a cup is not available, we advise the use of a graduated cylinder for liquids, preferably one holding 100 cubic centimeters and costing about 65 cents, which can be purchased from any supply house for scientific apparatus.

$2\frac{1}{2}$ cups measured will be nothing like an exact double of the $1\frac{1}{4}$ cups.

One way out of the difficulty is to measure with spoons, using those which are accurately calibrated, such as the ones that come in the cake-making set put out by Igleheart Brothers, Evansville, Indiana, manufacturers of Swans Down cake flour. To measure flour or sugar thus, dip the spoon into the material (sifted, if flour), bring it up rounding full, and level off the surface with the edge of a spatula. This method of measuring gives good results but is laborious.

Better than spoons or even the best of graduated cups are individual utensils for fractional parts of cups. These can be used

TABLE VIII

COMPARISON OF COMPUTED AND ACTUAL WEIGHTS OF FRACTIONAL PARTS OF A CUP OF FLOUR

Student	1 Cup (Grams)	½ Cup		⅓ Cup		¼ Cup	
		Computed (Grams)	Actual (Grams)	Computed (Grams)	Actual (Grams)	Computed (Grams)	Actual (Grams)
G. V.	93.4	46.7	46.1	31.1	31.7	23.3	23.2
F. J.	92.6	46.3	46.1	30.9	32.8	23.2	22.9
V. W.	94.1	47.1	47.0	31.4	31.5	23.5	23.0
I. N.	93.6	46.8	46.6	31.2	32.8	23.4	23.3

equally well for liquids and solids and make the measurement of small portions no more difficult than of large. Such utensils are shown in Figure 5. These we had made at considerable expense by a laboratory technician in collaboration with a supply house for scientific apparatus. By using these utensils with the precautions just specified, we are able to make our measurements of fractional parts of cups of solids agree very closely with the computed value. That is to say, if a cup of a given flour weighs 96 grams, a third of a cup should weigh 32 grams; and this it does very nearly when measured in our cups, as is shown by Table VIII. It was found also that the time required for measuring small portions of solids could be greatly reduced by using the small individual utensils. This was true for all solids but was particularly noticeable for fats.

FIG. 5.—Accurate, individual measuring-cups. Using these utensils, the careful worker is able to measure quite accurately fractional parts of cups of ingredients.

FIG. 6.—A mercury thermometer by which oven temperatures may be gauged. The one shown here is calibrated to read degrees Fahrenheit.

We are exceedingly sorry that our little measuring-utensils, being "hand wrought," are too expensive for general use. We think, however, that if a number of home economics laboratories would have such utensils made and try them out a demand might be created for them sufficient to persuade some manufacturer to make them.

SUMMARY OF MEASURING

Manipulation.—If cups or other utensils are so calibrated that they can be filled to the brim, we can check closely our own and each others' measurements by the following method of manipulation, provided we all use cups of like capacity.

a) Liquids: Fill the cup as full as it can be filled without danger of spilling the contents when it is carefully handled. Empty the cup completely by tapping it to dislodge the last clinging drops.

b) Fats: Pack the fat into a solid mass, being careful to press out all air spaces. Level off the top with *edge* of a spatula. The packing and leveling will be much easier to do if the fat is allowed to stand outside the refrigerator for an hour or so in winter and for a few minutes in summer.

c) Flour: Use recently sifted flour. Flour sifted several days previous to measuring may be as solidly packed as though it had not been sifted at all. Dip up heaping tablespoons of the flour and place them lightly in the cup, filling it slightly to overflowing without the least jarring or tapping, and level off the surface with the edge of a spatula; or sift the flour directly into the cup, filling it slightly overfull, and then level off the surface with the edge of a spatula. The second method of measuring averages about the equivalent of one tablespoonful less per cup than the first.

d) Granulated sugar: Use the same process as for measuring flour, save that the sugar need not be sifted before measuring.

e) Confectioner's sugar: Spread the sugar on the molding board and roll it with the rolling pin to remove lumps; then sift and measure by the same process as for flour. Measured thus, $1\frac{3}{4}$ cups of confectioner's sugar is the approximate equivalent of 1 cup of granulated sugar.

f) Brown sugar: Roll out the lumps, and measure by packing

solidly into a cup, using a spoon to press it down. Measured thus, the weight of 1 cup of brown sugar will show variation but will approximate that of 1 cup of granulated.

Utensils.—A standard capacity for measuring-cups has been chosen, but a large number of cups do not conform to the standard either in their total capacity or their subdivisions.

The names and addresses of the manufacturers of the best measuring-cups available can be obtained from *Good Housekeeping.*

The measurement of solids in the subdivisions of cups is difficult and time-consuming, even if the graduation marks are distinct and accurately placed. Until accurate individual utensils for the fractional parts of cups are available, measurement of small portions of liquid should be made in a graduated cylinder; of solids, in accurately calibrated spoons.

INGREDIENTS

Assuming that we have our measuring operations so well controlled that we can be fairly certain to measure the same quantity of a given ingredient from time to time,—or better, that we weigh all the troublesome ingredients—what happens if we substitute one ingredient for another? Suppose, for example, that we use bread flour when the recipe calls for pastry flour; water in place of milk, or vice versa; or that we replace one type of baking powder with another, Royal for Price's, or the other way around, will our results be equally good in all cases? In other words, can we say that a cup of one kind of flour will do the same work as a cup of any other kind, and that a teaspoon of baking powder is a teaspoon of baking powder and that is all there is to it?

The answer is *No.* When we begin to substitute in a recipe, we must also begin to modify it, a performance easy enough perhaps for an experienced cook but a hazardous undertaking for the inexperienced one with whom we are here chiefly concerned.

In order to make this point clear, let us review briefly some of the things which are known about baking powder and flour, the ingredients most apt to give us trouble if we substitute one type for the other without suitable modification of the recipe.

BAKING POWDER

There are three general types of baking powders on the market, all containing baking soda to furnish the carbon dioxide which leavens the dough, an acid to react with the soda and make it give up its carbon dioxide, and starch to act as a dehydrating agent and thus prevent premature reaction of the powder in the can. Each powder is named according to its acid-reacting component. When the acid is cream of tartar, or cream of tartar plus tartaric acid, we have a tartrate powder of which Royal and Schillings are the best-known brands. Another distinct type of powder has an acid phosphate of calcium as the acid component, and therefore gets the name of a phosphate powder. Of this kind Rumford's and Dr. Price's are leading examples. A third type of powder, frequently designated as S.A.S.-phosphate, has two acid components: an acid phosphate similar to that in the preceding type; and sodium aluminum sulphate, which for convenience is commonly abbreviated to S.A.S. Two well-known brands of this class are K C and Calumet.

Brands of powders not mentioned here can be classified by their acid components which are always named on the label.

All types of baking powders liberate approximately the same total volume of carbon dioxide, but they differ considerably in the amount formed in the cold, that is to say, before the dough is heated in the oven. This is indicated by the behavior of doughs made with the different types of powders and also by carbon-dioxide determinations on the powders themselves, or, better, on powders prepared especially for the purpose and made up to a given gas strength, using but *one* acid component in each.

Variations in the quantities of carbon dioxide liberated by "straight" powders of 14 per cent gas strength tested after they had been allowed to react with water in the cold for 2 and 15 minutes are given in Table IX. The action in a dough or batter would be less than with water alone; but according to these figures, we should expect tartrate powders to liberate much gas in the dough before it is heated, those containing sodium aluminum sulphate very little, with straight phosphate powders standing intermediate between the other two types in the amount of gas

formed in the cold. These expectations appear to be confirmed by actual baking experiments.

The various powders differ not only in the proportion of gas given off in the cold but also in the nature of the compounds formed as a result of the reaction between soda and the acid. These compounds have been found to have some action on the other components of the dough,[1] but not enough work has been done to make any practical application possible.

TABLE IX

CARBON DIOXIDE LIBERATED FROM BAKING POWDERS HAVING ONE ACID REACTING COMPONENT WHEN TREATED WITH WATER AT 25° C.
(DR. J. R. CHITTICK)

Acid-Reacting Component	Total Carbon Dioxide	Carbon Dioxide Liberated in 2 Minutes by Water	Carbon Dioxide Liberated in 15 Minutes by Water
	per cent by weight	per cent by weight	per cent by weight
Tartaric acid	14.0	13.8	14.0
Cream of tartar	14.0	10.6	13.8
Monocalcium phosphate	14.0	8.6	9.3
Sodium aluminum sulphate	14.0	3.2	6.2

To avoid confusion, the facts just stated have been summarized in Table X.

Considering the difference in the rate of reaction in the cold and in the nature of the salts formed, it is at once evident that we cannot use different types of baking powders interchangeably without making certain changes in our recipes. This is more especially true for muffins and cakes than for biscuits. In general these changes are concerned with the proportion of powder and the optimum beating-time, which will be stated specifically in each recipe. If these recipes are followed, it will be found that perfectly good products can be made from all three types of powders.

FLOUR

Most grocers carry two types of flour: one made from soft wheat, and known as "pastry flour" or, under certain conditions

[1] Florence C. Smith and C. H. Bailey, "The Effect of Chemical Leavening Agents on the Properties of Bread," *Journal of the American Association of Cereal Chemists*, VIII (1923), 183–94.

of manufacture, as "cake flour"; the other made from a blend of soft and hard wheat and commonly called a "general-purpose or family flour."

These two types of flour differ from each other chiefly in the quantity and quality of a peculiar protein called "gluten" which they yield. A difference in amount, and to some extent in kind, of gluten can be shown by washing this protein from equal weights of samples of the two types of flour under standard conditions.[1]

TABLE X

SUMMARY OF PRECEDING STATEMENTS REGARDING BAKING POWDERS

Type of Powder	Acid Component	Some Well-known Brands	Order of Gas Liberation in the Cold	Soluble Compounds Formed Which Remain in the Baked Product
Tartrate	Cream of tartar and tartaric acid	Royal Schilling	1	Potassium sodium tartrate and sodium tartrate
	Cream of tartar	Monarch	2	Potassium sodium tartrate
Phosphate	Monocalcium phosphate	Rumford's Dr. Price's Farm House Yacht Club Red Front Webb's	3	Disodium phosphate
S.A.S.-phosphate	Monocalcium phosphate and sodium aluminum sulphate	K C Calumet Davis O K	4	Sodium sulphate and some disodium phosphate

Briefly, this washing process consists in making a stiff dough ball which is allowed to stand under water for a certain length of time and then kneaded under running water over a bolting-cloth sieve until all the starch is removed and the gluten is left behind as an elastic ball. On comparing the balls made from the two kinds of flour, it will be found that the one from family flour has a greater volume and weight and that it also has a different consistency, being, in general, somewhat tougher; in other words, it has a

[1] Albert E. Leach, *Food Inspection and Analysis* (4th ed., New York: John Wiley and Sons, Inc., 1920), p. 331; D. B. Dill and C. L. Alsberg, "Some Critical Considerations of the Gluten Washing Problem," *Cereal Chemistry*, I (1924), 222–46.

greater resistance to breaking when stretched. The balls from both flours, however, are very elastic, as can be shown by stretching them with the fingers or, better still, by baking them in a hot oven, whereupon they will be found to expand to many times their original volume. Figure 16, facing page 66, shows the relative volumes of the wet and baked glutens washed from 25 grams each of a family and a pastry flour, which, though chosen at random, are fairly representative of such other samples of the two types of flour as we have examined. The weights of the two glutens before baking were 6.5 and 9 grams, or 26 and 36 per cent, respectively, for the pastry and family flour.

Aside from expanding and holding its shape when baked, gluten also has the property of absorbing much water. Just how much of the moisture-absorbing capacity of a given flour is dependent on its gluten and how much on its starch seems to be an unsettled question. Certain it is, however, that flours differ greatly in this property, family flours in general absorbing more than do pastry. This can be demonstrated readily enough by weighing a given portion of a sample of each type of flour (say 100 grams) and adding slowly to each exactly the same volume of water (50 to 60 cubic centimeters, for example), then working the two mixtures into doughs. If the amount of water used is just enough to make a good smooth dough with the family flour, it will make a soft sticky one with the pastry flour. Conversely, if the pastry-flour dough is just right, the one with family flour will be exceedingly stiff and not at all smooth and elastic.

This difference in moisture-absorbing capacity gives trouble when one changes from one type of flour to the other in a given recipe, a fact which is especially noticeable in biscuits. For these, as will be discussed later (p. 104), a large part of the success of the process consists in obtaining a dough of a certain consistency. Obviously, if one flour absorbs much more liquid than the other, we cannot use the same proportions of the two for a given volume of liquid. Provided we have the right proportions, however, it does not seem to make much difference which type of flour we use for muffins, biscuits, and pie crusts; but pastry flour seems necessary for cakes if they are to be at their best.

What has been said thus far would indicate that all family and all pastry flours possessed similar properties and that, as a consequence, different brands of a given type could be used one for the other without a change in the recipe. Unfortunately this is not true, but comes more nearly being so if we weigh rather than measure our ingredients, because variation in the weight of a given measure appears to be one outstanding difference among different brands of the same type of flour. Twenty-five samples of pastry flour were weighed and measured in this laboratory, and the weight of 1 cupful was found to vary from 88 to 102 grams[1]—a difference of 14 grams, which is something over 2 tablespoons. Similar differences were observed for family flour. Since we could find no fixed value for a cup of a given type of flour, we chose weights which represent averages for the flours used in this laboratory. This for pastry, including cake flour, is 96 grams; for family, 113 grams.

We have, as yet, been able to make baking-tests on but a small number of the flours which we have weighed and measured. Of these, a number gave equally good results when used in exactly similar proportions by weight; a few others did not. Of the latter we have made no attempt to find what proportion, if any, would give good results. The following are the ones we have used successfully:

a) *Family flours.*—Pillsbury XXXX, Gold Medal, and a Sprague Warner product put out under the Richelieu brand.

b) *Pastry flour.*—Richelieu Pastry.

c) *Cake flour.*—Swans Down, Gold Medal Cake, and Airy Fairy.

For all we know, there are hundreds of other brands which would have given us equally good results had we tried them; therefore we hesitate to single these out for special preference. Our reason for doing so is to help the inexperienced person, with whom, as already stated, we are chiefly concerned. We suggest that such a person work with one of the flours we recommend until she is sure of her technique, and then, if she wishes, experiment with such other brands as may be obtained conveniently in her

[1] Experimental work done by Dr. Emily Grewe.

own neighborhood. This very thing was done recently with cakes in our laboratory. A young woman who was able to make excellent cakes with one of the flours we used, tried two others. With one, her cakes were a failure; with the other, they were first class. The flour which gave the good cakes, it happened, was an inexpensive one produced in her own vicinity.

MANIPULATION OR METHOD OF COMBINING INGREDIENTS

In order to find to what extent baking failures are traceable to manipulation, we have made a large number of cakes, muffins, and biscuits in which the method of combining the ingredients was, so far as we know, the only variable. This was accomplished by using the same proportions throughout for each product, taking all ingredients from the same supply, weighing everything that was used, and baking all at a given temperature.

In every case we found that the way we combined our ingredients could either make or mar the product. For example, equal weights of the very same flour, same milk, same baking powder, same everything, gave the light, fluffy muffin shown in Figure 11, facing page 48, or the soggy, misshapen, tunneled one of Figure 12, depending on whether we stirred only enough to dampen the dry ingredients or whether we did a little extra stirring. Judging from our results, we conclude that for each type of baked product, indeed for each recipe, there is at least one, maybe several, satisfactory methods of combining the ingredients, and most certainly any number of unsatisfactory ones. The methods given here are the ones the writers have found best of all that were used, and they are the only ones which we care to recommend. We can vouch for them, however, only when one uses the ingredients specified in the amounts designated and bakes at the temperatures suggested.

Right here we should like to state that we have found that our manipulation is conditioned by the utensils used—their shape and, for a given quantity of material, their size. For all types of batters and doughs we much prefer a porcelain or heavy glass bowl with a slope similar to that shown in Figure 7. Such a bowl is heavy enough to keep its position and not slide around with the

FIG. 7.—A convenient mixing bowl. The advantages of this bowl are (1) the sloping sides which round gradually into the bottom, thereby making effective stirring possible, and (2) the weight, which is sufficient to keep the bowl from turning with every movement.

FIG. 8.—An inconvenient mixing bowl. The disadvantages of this bowl are the light weight and the straight sides, which, together with the trough at the bottom, make effective stirring difficult.

slightest touch, and it has a slope which makes effective stirring possible. Moreover, it is easy to turn out batters or remove doughs from such a bowl. Bowls with a slope more nearly approaching the perpendicular, especially those with a sort of trough at the bottom, like that in Figure 8, are particularly exasperating to use. The sides come in so close that they hamper one's movements in stirring and decrease one's speed in removing the batter or dough.

The kind and shape of spoon used also makes a difference in the manipulation of ingredients. Metal spoons bruise the hand and make effective stirring difficult; hence wooden spoons should be used. We prefer light-weight ones with very shallow bowls.

No matter how favorable the shape of the bowl and stirring spoon, however, we find we cannot stir in our accustomed way (that is, the way which gives us good results) if the bowl is more than half-full when all the ingredients are in it, in other words, if the depth of the batter is more than two-thirds that of the bowl. If the bowl is fuller than this, we have to stir carefully to prevent flour or liquid, maybe both, from spattering out of it, with the result that we change our usual procedure altogether and with it the character of the finished product. We have, it will be noted, stated for each recipe the size of the bowl we have found most convenient for use.

OVEN TEMPERATURES

With our carefully made product safely in the tin we have still one more chance to spoil it in the baking. Take cakes, for example: If the oven is too hot, the top crusts over before the cake has risen sufficiently (in other words, while gas is still forming and expanding), with the natural result that the cake cannot rise any more until the interior pressure becomes great enough to break the crust at its weakest point, which is near the center. When this happens, the dough is forced out of the cracks in unsightly ridges. If the oven is not hot enough, the walls of the gas pockets apparently do not stiffen in time to prevent their being stretched beyond their holding capacity, with the result that they break and the cake is very coarse and tends to shrink.

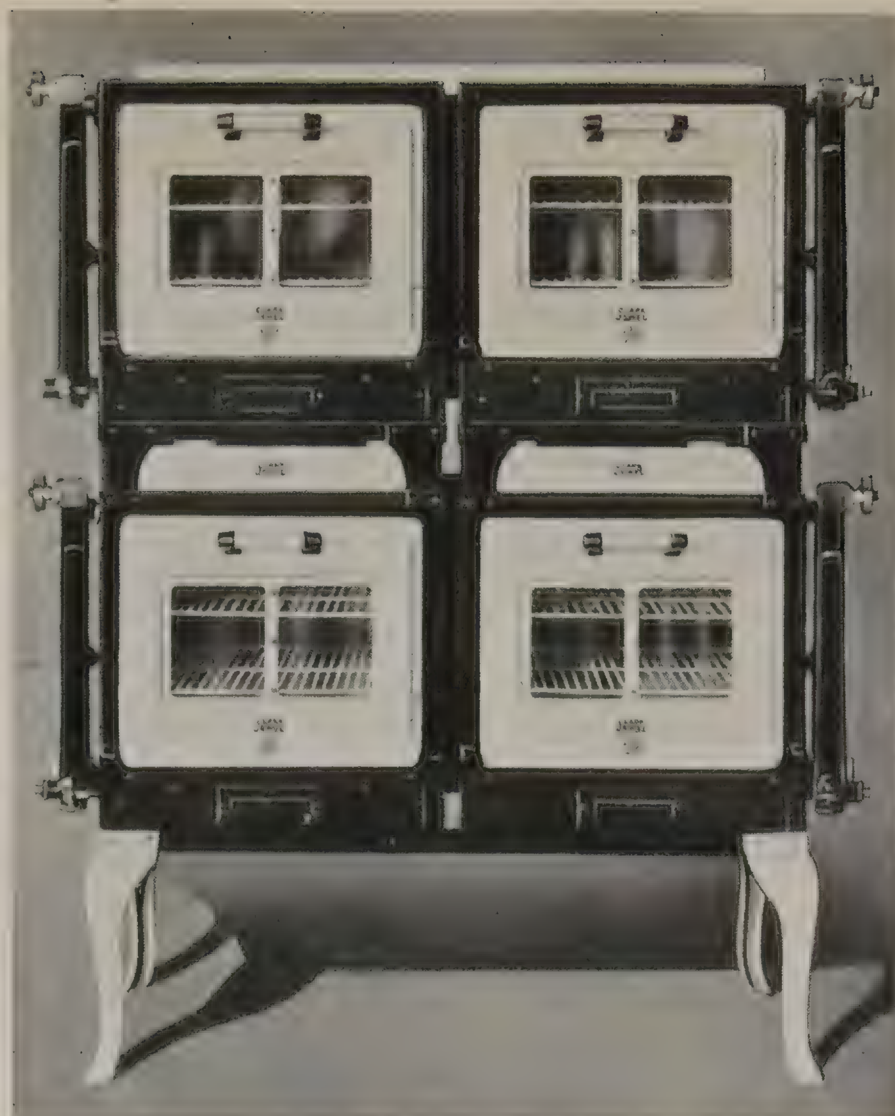
Similarly with other products, the temperature of baking is a

most important matter and varies with the ingredients used. An angel cake, for example, with its large proportion of egg white, would be very tough if baked at the temperature recommended for the ordinary butter cake. The optimum baking temperatures, however, have been fairly well worked out, so that no one need fail to know what temperature she should have for a given product. The difficulty is in getting and maintaining such a temperature unless one has an oven equipped with a heat-regulator, as are the gas ovens shown in Figure 9. These ovens, it will be noted, are provided with glass doors, which are a material advantage in learning to bake. Unfortunately glass doors are not very popular with stove-manufacturers; hence they are uncommon save in ovens made specially for home economics laboratories, as are those pictured in Figure 9. This set of four ovens was obtained from the George M. Clark Company, Chicago, at a cost of something like \$175.00. It is without broilers or gas plates for cooking, and is used exclusively for baking.

Although regular gas ranges[1] for ordinary home use rarely have ovens with glass doors, many of them are equipped with reliable oven-regulators, such as the Lorain used on our ovens and shown in approximately natural size in Figure 10. This regulator is manufactured by the American Stove Company and is used on the six different gas ranges made by them—Quickmeal, Reliable, Clark Jewel, New Process, Dangler, and Quick Action. The price of these ranges in a type suitable for use in the average home runs anywhere from \$55.00 to \$135.00, depending upon the size and the amount of enamel used in their construction.

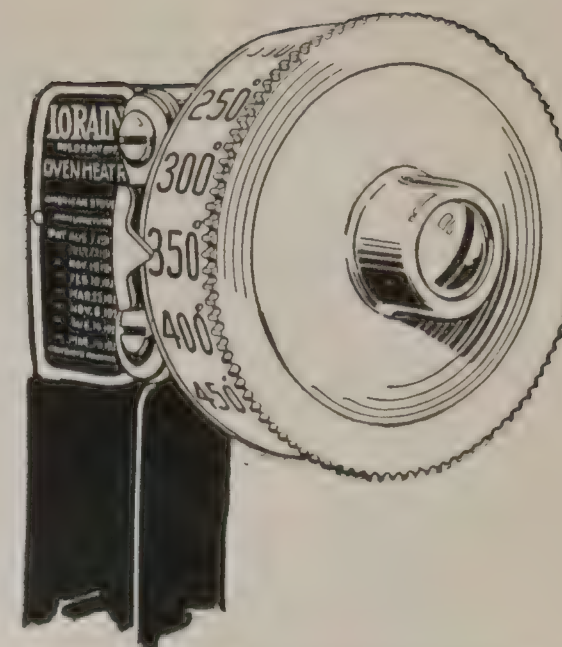
In the main, Lorain regulators are reliable and can be depended upon to maintain any desired temperature in baking. Like everything else, however, they may get out of order in time; hence for careful work we find it advisable to check them with mercury oven-thermometers similar to the one shown in Figure 6. Such thermometers are manufactured by the Taylor Instrument Companies, Rochester, New York. They may be ob-

[1] We are confining our discussion on ovens to those heated with gas, for the simple reason that our work in baking chances to have been done exclusively with such ovens.



Courtesy of George M. Clark and Company, Chicago

FIG. 9.—A set of four gas ovens, each equipped with a regulator. Glass doors like the ones on these ovens are particularly helpful when learning to bake.



Courtesy of George M. Clark and Company, Chicago

FIG. 10.—A close view of the regulator with which the ovens in Figure 9 are equipped.

tained from the manufacturers, from any supply house for scientific apparatus, and also from many hardware dealers, at a cost of about $2.00. The newer ones are white and are much easier to read than the older ones, which were brown.

In checking oven-regulators with Taylor thermometers, one must see to it that the thermometer itself is in good condition, for thermometers, too, may get out of order. One way to test a thermometer is to check it against another one. What we really do is to use two Taylor thermometers placed side by side in the center, and by "center" we mean a position equidistant from the top and bottom, as well as from the sides and back and front, of an otherwise empty oven. If, and only if, the two Taylors agree and register a temperature higher or lower than that for which the regulator was set, we assume that the regulator is at fault and send for our local agent to come and readjust it.

If one must use an oven not equipped with a heat-regulator, particularly one heated by coal or wood, learning how to bake is a tedious process, which may be much simplified, however, by use of a mercury oven-thermometer.

No matter how we regulate the heat, it should be realized that few, if any, ovens have an absolutely uniform temperature throughout. There is usually considerable difference between the temperature of the center and of the extreme edges. Obviously, the center offers a larger area of uniform heat than any other spot which can be chosen; hence it is here that the product should be placed in baking. If the oven must be filled full, we shall have to resort to occasional turning in order to get uniform baking for everything.

The baking temperatures given in the recipes which follow are the ones we have found most satisfactory; and we feel certain they will give good results provided the directions have been followed in choosing, measuring, and combining the ingredients.

REMARKS CONCERNING THE ARRANGEMENT AND USE OF THE DIRECTIONS FOR COOKING

What has been said thus far about batters and doughs applies equally well to all members of the series; what comes next is

specific for each product considered—muffins, cakes, biscuits, and pastry—a chapter being devoted to each.

The material in these chapters consists of a description of what we consider a standard product, with pictures of the same if such could be obtained; a detailed discussion of the factors which we have found to contribute toward both success and failure; and a set of recipes. These recipes are given in detailed form and are really a résumé of the discussion.

It is not expected that anyone should have these long recipes before her when actually cooking. In fact, if such a procedure is attempted, we can predict failure from the start, since the delay caused by trying to figure out what to do next and how to do it will in itself be sufficient to ruin the product. The plan we suggest, taking muffins as an illustration, is this: Read carefully the specific discussion on muffins—how a good muffin should look, what ingredients to use, what manipulation to follow, and how to bake. After this, read over the recipe for the particular kind of muffin to be made and, when a choice is given between different ingredients, decide which ones are to be used. Then write an abbreviated recipe, setting down only those things which are hard to remember, such as proportion of ingredients and the suggested length of the stirring and baking periods. The abbreviated recipe for muffins given on page 52 is not meant as a model but simply as a suggestion for the sort of thing each person should write for herself.

It will be observed that, for the most part, each of the following recipes is complete in itself, with no mention made of its similarity to another from which it may have been derived. Thus the recipes for the different kinds of muffins are given in detail, although all are quite similar to that for plain muffins and could be written as modifications of it. This was not done because of the confusion and consequent annoyance which results from trying to assemble the parts of a scattered recipe. Similarly with the cake recipes: most of these are closely related, but for simplicity each is written as a unit complete in itself.

CHAPTER III

MUFFINS

CHARACTERISTICS OF GOOD MUFFINS

To be good, muffins should be very light, so light in fact that when one picks them up one is surprised that anything of their size should weigh so little. The outside should be baked to a golden-brown shade, should be symmetrical in shape with no tendency to form peaks or knobs at the top, and should have a somewhat pebbled, rather than a smooth, even, surface. The inside should show round holes of fairly uniform size but should have none of the long, narrow ones sometimes called "tunnels."

INGREDIENTS

Flour.—So far as our experience goes, muffins made with pastry flour are somewhat nicer than those made with family flour, but the difference between the two is not pronounced. We find, in fact, that very good muffins can be made from the two types of flour used in exactly the same weight, which by measure means about 3 tablespoons per cup more of pastry than of family.

Liquid.—Muffins are just as good made with sour milk or cream as with sweet, provided the sour has not been allowed to stand until it has developed an unpleasant taste, and provided a very little soda is used, just barely enough to neutralize the acid of the milk or cream. We have our best results when we use but ½ teaspoon of soda per cup of sour milk and about half to three-fourths as much baking powder as is used with sweet milk or cream.

Fat.—Cooking oils and fats of low melting-point, such as butter and Crisco, are the only ones which can be used successfully in muffins made according to our directions. This is because we add the fat—melted if a solid one—to the milk-egg mixture instead of to the otherwise finished batter—as is a common practice. A fat with a high melting-point, such as have some of

the hydrogenated ones, would solidify almost immediately upon coming in contact with the cold milk-egg mixture. In this condition it could not be well combined with the other ingredients in the short stirring-period required by muffins, and as a result the texture of the muffins would be very coarse.

MANIPULATION OF INGREDIENTS

The one important thing in making muffins is to work quickly. The difference between success and failure is a matter of a few seconds. Muffin batter has such a large proportion of liquid that the baking powder reacts quickly and the gas readily passes off. Furthermore, in plain muffins, such as we are considering, very little sugar is used; and according to a study made on cakes by Miller and Allen,[1] batters low in sugar do not retain gas well. Hence, if we take too long in combining[2] the ingredients, we stir out much of the gas, with the result that our muffins are soggy, peaked, and tunneled, like that of Figures 12 and 14. The only difference between this and the one pictured in Figures 11 and 13 is that the poor one was stirred a few seconds longer.

Unfortunately we can give no one stirring-time which can be counted on to give equally good results under all conditions, for the optimum time varies with the individual's rate and vigor of movement and with the type of baking powder used. A general rule, however, which works fairly well for everybody and for all types of baking powders, is to stir as fast as possible and to stop the instant the dry ingredients are dampened. This does not mean stir until all lumps are out and a smooth batter is obtained, but just what it says, *until all dry ingredients are dampened.* As we stir, this takes 17 seconds, beginning to count the time with the first stroke made after turning the mixed liquid ingredients all at once into the dry ones. This time does not hold for everybody. One student in our laboratory, for example, was able to reach the "just dampened" stage in 10 seconds, while others have taken

[1] "Problems in Cake Making," *Journal of Home Economics*, X (1918), 542–47.

[2] We have found that the combining process is most easily accomplished by moving the spoon around and around the bowl with a circular motion. This movement should always be as vigorous as possible.

FIG. 11.—Exterior view of a muffin made by an inexperienced person who *had* been warned against overstirring. The symmetrical shape, the somewhat pebbled surface, and the height are all characteristic of a good muffin.

FIG. 12.—Exterior view of a muffin made by an inexperienced person who *had not* been warned against overstirring. The knoblike projection is an earmark of overstirred muffins.

FIG. 13.—Interior view of the muffin shown in Figure 11. The slightly rounded top and the freedom from large holes and tunnels are characteristic of good plain muffins.

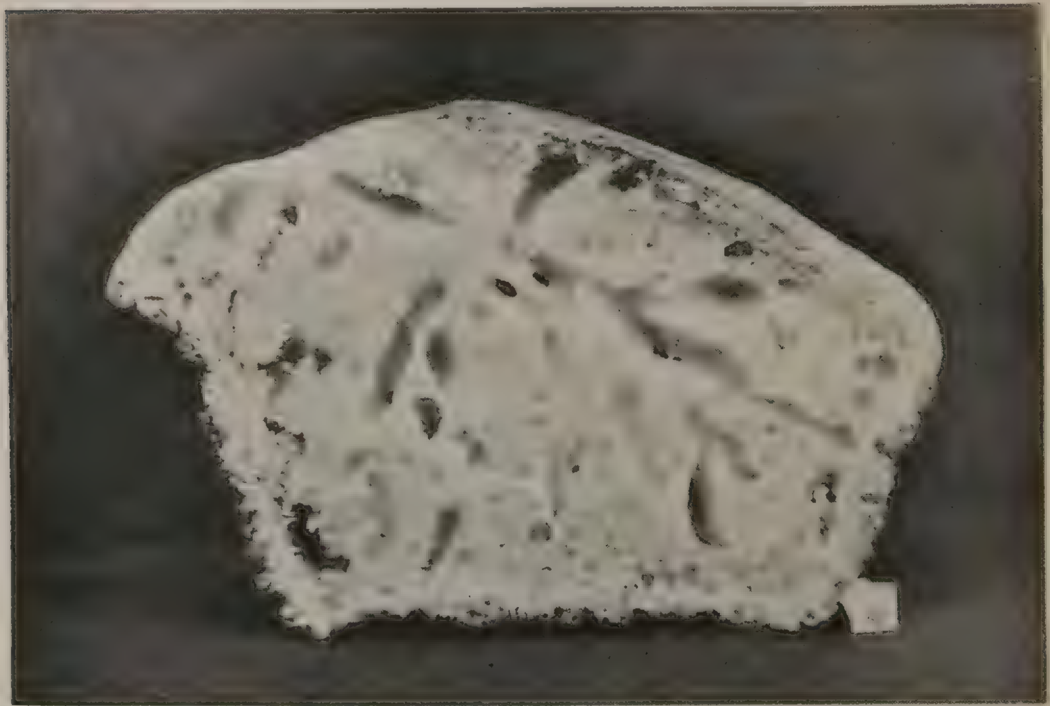


FIG. 14.—Interior view of the muffin shown in Figure 12. The long, tunnel-like holes are as characteristic of overbeaten muffins as are knoblike projections.

anywhere up to 28 seconds, all of us obtaining muffins of practically the same quality. When tartrate powders are used, stirring only "to dampen" gives optimum results; and any further stirring is harmful. With other types of powder, muffins made thus are light but somewhat coarse. They are, however, made similar to the tartrate ones by a few extra strokes, such, for example, as we are able to give in 3 seconds additional stirring, making a total of 20 seconds for our whole combining period.

The beginner who really wants to learn to make good muffins should time her stirring operations during the learning period and try to correlate the time used with the appearance of the batter and of the finished muffins. If the latter are coarser than the one in Figure 13, she has not stirred long enough; if they show tunnels and peaks, as in Figure 14, she has overstirred them. Somewhere between the two extremes is the happy mean at which she will soon be able to arrive without timing herself, simply by knowing how the batter should look when she stops stirring.

Muffins should be placed in the pans as soon as one stops stirring them. In doing this, handle the batter with care, taking it up by spoonfuls and placing it lightly in the pans. Rough handling will cause loss of carbon dioxide and therefore tend to make the muffins heavy.

Short standing in the pans, say 10 to 15 minutes before baking, does no harm; indeed, it appears to improve those made with S.A.S.-phosphate baking powder.

DIRECTIONS FOR THE PREPARATION OF MUFFINS

Before attempting to use these recipes, read the preceding discussion of muffins and the section on weighing and measuring (page 26).

Yield

Each muffin recipe makes 10 muffins about 2½ inches in diameter and 1½ inches high.

Utensils

A 2-quart, heavy mixing-bowl, similar in shape to the one shown in Figure 7 (facing page 42).

Baking pans

Total capacity: 1,000 cubic centimeters (approximately $4\frac{1}{4}$ cups).

In this laboratory 10 muffin-pan sections, each holding 100 cubic centimeters (approximately 7 tablespoons), are used.

PLAIN MUFFINS: SWEET MILK

Proportion of ingredients

	WEIGHT IN GRAMS	APPROXIMATE MEASURE
Flour		
Pastry	216.0	$2\frac{1}{4}$ cups
or		
Family	216.0	2 cups minus 1 tablespoon
Baking powder		
Tartrate	15.4	4 teaspoons
or		
Calcium-phosphate	16.0	4 teaspoons
or		
S.A.S.-phosphate	12.0	3 teaspoons
Sugar	25.0	2 tablespoons
Salt		$\frac{1}{2}$ teaspoon
Egg	48.0	1 medium sized
Milk	244.0	237 cubic centimeters (1 cup)
Fat (melted or a liquid fat)	40.0	3 tablespoons

Order of work: Detailed form

1. Assemble the ingredients and the utensils needed in the preparation of the muffins. Oil the muffin tins.
2. Light the oven. Set it at 425° Fahrenheit if a tartrate or calcium-phosphate baking powder is to be used, or at 300° F. if a S.A.S.-phosphate powder is to be used.
3. (*a*) Weigh or measure the flour, baking powder, and sugar. Measure the salt. Mix these together; then sift them into the mixing bowl.

b) Beat the egg until it is foamy.
c) Weigh or measure the milk. Turn it into the egg.
d) Weigh or measure the fat. (If one of the solid fats is used, melt it before weighing or measuring.) Turn it into the egg-milk mixture.

4. Combine the wet and dry ingredients as follows:

Just as soon as the fat has been poured into the egg and milk mixture, turn the wet ingredients into the dry ones all at one time, and immediately start to combine the two by stirring as *vigorously* as possible without spattering the mixture out of the bowl.

If a tartrate powder has been used, stop stirring the instant the dry ingredients are *just dampened*. (This will probably take from 10 to 20 seconds.) The batter will look very lumpy.

If a calcium-phosphate or a S.A.S.-phosphate baking powder has been used, stir until the dry ingredients are just dampened, then for about 3 seconds longer (4 to 5 strokes). This batter will appear less lumpy than that mentioned above, but will not yet have become perfectly smooth.

Special care should be taken to avoid overstirring, for muffins are more easily ruined by this than by any other means. Just a few seconds overbeating makes the muffin batter rise to peaks and be full of large holes.

As soon as the beating-period is over, dip the batter into the muffin tins with as little stirring as possible. Fill each section about two-thirds full.

5. Bake the muffins as follows:

If a tartrate or calcium-phosphate baking powder was used, bake at 425° F. until the crusts are golden brown (about 20 minutes). If a S.A.S.-phosphate powder was used, bake at 300° F. for about 5 minutes (or until the batter has risen to almost double its original height), then at 425° F. for about 15 minutes longer.

6. Remove the muffins from the tins immediately after taking them out of the oven, and serve them *at once*.

Order of work: Abbreviated form

If the person who makes the muffins chooses to weigh the flour and measure all other ingredients and to use a calcium-phosphate baking powder and a solid fat, a résumé of the recipe is somewhat as follows:

1. Light the oven (425° F.).
2. Weigh or measure the ingredients:

Flour	216 grams	Mix, then sift together
Baking powder	4 teaspoons	
Sugar	2 tablespoons	
Salt	½ teaspoon	
Egg	1 medium sized	Mix together
Milk	237 cubic centimeters	
Melted fat	3 tablespoons	

3. As soon as the melted fat has been added to the egg and milk, pour these ingredients into the dry ones, and start to stir as vigorously as possible.
4. Stir until the dry ingredients have become just dampened (between 10 and 20 seconds); then continue stirring for 4 or 5 strokes more (3 seconds).
5. Avoid stirring the batter when it is being lifted from the bowl to the tins.
6. Bake until the crusts are a golden brown (about 20 minutes).

PLAIN MUFFINS: SOUR MILK

If thick sour milk is used instead of sweet milk, follow the recipe for sweet milk plain muffins save for the following changes:

1. Use 1½ teaspoons (instead of 3) of S.A.S.-phosphate baking powder; 2 teaspoons (instead of 4) of tartrate or calcium-phosphate baking powder.
2. Use ½ teaspoon of soda and 1 tablespoon of water. Mix the two together and stir into them the other wet ingredients.

PLAIN MUFFINS: SWEET CREAM

Proportion of ingredients

	WEIGHT IN GRAMS	APPROXIMATE MEASURE
Flour		
Pastry	192.0	2 cups
or		
Family	192.0	$1\frac{3}{4}$ cups
Baking powder		
Tartrate	15.4	4 teaspoons
or		
Calcium-phosphate	16.0	4 teaspoons
or		
S.A.S.-phosphate	12.0	3 teaspoons
Sugar	25.0	2 tablespoons
Salt		$\frac{1}{2}$ teaspoon
Egg	48.0	1 medium sized
Cream (18 per cent)	239.0	1 cup

Order of work: Detailed form

1. Assemble all ingredients and utensils needed in the preparation of the muffins. Oil the muffin tins.
2. Light the oven. Set it at 425° Fahrenheit if a tartrate or calcium-phosphate baking powder is to be used, or at 300° F. if a S.A.S.-phosphate powder is to be used.
3. (*a*) Weigh or measure the flour, baking powder, and sugar. Measure the salt. Mix these together; then sift them into the mixing bowl.
   b) Beat the egg until it is foamy.
   c) Weigh or measure the cream. Turn it into the egg.
4. Combine the wet and dry ingredients as follows:

   Turn the wet ingredients into the dry ones all at one time, and immediately start to combine the two by stirring as *vigorously* as possible without spattering the mixture out of the bowl.

If a tartrate powder has been used, stop stirring the instant the dry ingredients are *just dampened*. (This will probably take from 10 to 20 seconds.) The batter will look very lumpy when the stirring-period is over.

If a calcium-phosphate or a S.A.S.-phosphate baking powder has been used, stir until the dry ingredients are just dampened, then for about 3 seconds longer (4 to 5 strokes). This batter will appear less lumpy than that mentioned above, but it will not yet have become perfectly smooth.

Special care should be taken to avoid overstirring, for muffins are more easily ruined by this than by any other means. Just a few seconds of overbeating makes the muffins rise to peaks and be full of large holes.

As soon as the beating-period is over, dip the batter into the muffin tins with as little stirring as possible. Fill each section about two-thirds full.

5. Bake the muffins as follows:

   If a tartrate or calcium-phosphate baking powder was used, bake at 425° F. until the crusts are a golden brown (about 20 minutes). If a S.A.S.-phosphate powder was used, bake at 300° F. for about 5 minutes (until the batter has risen to almost double its original height), then at 425° F. for about 15 minutes longer.

6. Remove the muffins from the tins immediately after taking them from the oven, and serve them *at once.*

PLAIN MUFFINS: SOUR CREAM

If freshly soured cream is used instead of sweet cream, follow the recipe for sweet-cream muffins except for the following changes:

1. Use 2 teaspoons (instead of 4) of tartrate or calcium-phosphate baking powder; 1½ teaspoons (instead of 3) of S.A.S. phosphate baking powder.
2. Use ½ teaspoon of soda and 1 tablespoon of water. Mix the two together and stir into them the other wet ingredients.

GRAHAM MUFFINS: SWEET MILK

Proportion of ingredients

	WEIGHT IN GRAMS	APPROXIMATE MEASURE
Flour		
Pastry	96.0	1 cup
or		
Family	96.0	$\frac{7}{8}$ cup
Baking powder		
Tartrate	15.4	4 teaspoons
or		
Calcium-phosphate	16.0	4 teaspoons
or		
S.A.S.-phosphate	12.0	3 teaspoons
Sugar	25.0	2 tablespoons
Salt		$\frac{1}{2}$ teaspoon
Graham flour	145.0	$1\frac{1}{4}$ cups
Egg	48.0	1 medium sized
Milk	244.0	237 cubic centimeters (1 cup)
Fat (melted or a liquid fat)	40.0	3 tablespoons

Order of work: Detailed form

1. Assemble all ingredients and utensils needed in the preparation of the muffins. Oil the muffin pans.
2. Light the oven. Set it at 425° Fahrenheit if a tartrate or calcium-phosphate baking powder is to be used, or at 300° F. if a S.A.S.-phosphate powder is to be used.
3. (*a*) Weigh or measure the white flour, baking powder, and sugar. Measure the salt. Mix these together; then sift them into the mixing bowl.
   b) Weigh or measure the graham flour. Stir it into the mixture of flour, baking powder, sugar, and salt.
   c) Beat the egg until it is foamy.
   d) Weigh or measure the milk. Turn it into the egg.
   e) Weigh or measure the fat. (If one of the solid fats is

used, melt it before weighing or measuring.) Turn it into the egg-milk mixture.

4. Combine the wet and dry ingredients as follows:

   Just as soon as the fat has been poured into the egg and milk mixture, turn the wet ingredients into the dry ones all at one time, and immediately start to combine the two by stirring as *vigorously* as possible without spattering the mixture out of the bowl.

   If a tartrate powder has been used, stop stirring the instant the dry ingredients are *just dampened.* (This probably will take from 10 to 20 seconds.)

   If a calcium-phosphate or a S.A.S.-phosphate baking powder has been used, stir until the dry ingredients are just dampened, then for about 3 seconds longer (4 to 5 strokes).

   Special care should be taken to avoid overstirring, for muffins are more easily ruined by this than by any other means. Just a few seconds of overbeating makes the muffin batter rise to peaks and be full of large holes.

   As soon as the beating-period is over, dip the batter into the muffin tins with as little stirring as possible. Fill each section about two-thirds full.

5. Bake the muffins as follows:

   If a tartrate or calcium-phosphate baking powder was used, bake at 425° F. until the crusts are golden brown (about 25 minutes). If a S.A.S.-phosphate powder was used bake at 300° F. for about 5 minutes (or until the batter has risen to almost double its original height), then at 425° F. for about 20 minutes longer.

6. Remove the muffins from the tins immediately after taking them out of the oven, and serve them *at once.*

GRAHAM MUFFINS: SOUR MILK

If sour milk, freshly clabbered, is used instead of sweet milk, follow the recipe for sweet-milk graham muffins except for the following changes:

1. Use 3 teaspoons (instead of 4) of tartrate or calcium-phosphate baking powder; 2 teaspoons (instead of 3) of S.A.S.-phosphate baking powder.

2. Use ½ teaspoon of soda and 1 tablespoon of water. Mix the two together and stir into them the other wet ingredients.

GRAHAM MUFFINS: SWEET CREAM

Proportion of ingredients

	WEIGHT IN GRAMS	APPROXIMATE MEASURE
Flour		
Pastry	72.0	¾ cup
or		
Family	72.0	⅔ cup
Baking powder		
Tartrate	15.4	4 teaspoons
or		
Calcium-phosphate	16.0	4 teaspoons
or		
S.A.S.-phosphate	12.0	3 teaspoons
Sugar	25.0	2 tablespoons
Salt		½ teaspoon
Graham flour	116.0	1 cup
Egg	48.0	1 medium sized
Cream (18 per cent)	239.0	1 cup

Order of work: Detailed form

1. Assemble all ingredients and utensils needed in the preparation of the muffins. Oil the muffin tins.
2. Light the oven. Set it at 425° Fahrenheit if a tartrate or calcium-phosphate baking powder is to be used, or at 300° F. if a S.A.S.-phosphate powder is to be used.
3. (*a*) Weigh or measure the white flour, baking powder, and sugar. Measure the salt. Mix these together; then sift them into the mixing bowl.

   b) Weigh or measure the graham flour. Stir it into the mixture of flour, baking powder, sugar, and salt.

c) Beat the egg until it is foamy.

d) Weigh or measure the cream. Turn it into the egg.

4. Combine the wet and dry ingredients as follows:

   Turn the wet ingredients into the dry ones all at one time, and immediately start to combine the two by stirring as *vigorously* as possible without spattering the mixture out of the bowl.

   If a tartrate powder has been used, stop stirring the instant the dry ingredients are *just dampened.* (This probably will take from 10 to 20 seconds.)

   If a calcium-phosphate or a S.A.S.-phosphate baking powder has been used, stir until the dry ingredients are just dampened, then for about 3 seconds longer (4 to 5 strokes).

   Special care should be taken to avoid overstirring, for muffins are more easily ruined by this than by any other means. Just a few seconds overbeating makes the muffin batter rise to peaks and be full of large holes.

   As soon as the beating-period is over, dip the batter into the muffin tins with as little stirring as possible. Fill each section about two-thirds full.

5. Bake the muffins as follows:

   If a tartrate or calcium-phosphate baking powder was used, bake at 425° F. until the crusts are golden brown (about 25 minutes). If a S.A.S.-phosphate powder was used, bake at 300° F. for about 5 minutes (or until the batter has risen to almost double its original height), then at 425° F. for about 20 minutes longer.

6. Remove the muffins from the tins immediately after taking them out of the oven, and serve them *at once.*

GRAHAM MUFFINS: SOUR CREAM

If freshly soured cream is used instead of sweet cream, follow the recipe for sweet-cream graham muffins except for the following changes:

1. Use 3 teaspoons (instead of 4) of tartrate or calcium-phosphate baking powder; use 2 teaspoons (instead of 3) of S. A. S.-phosphate baking powder.
2. Use ½ teaspoon of soda and 1 tablespoon of water. Mix the two together and stir into them the other wet ingredients.

CORN-MEAL MUFFINS: SWEET MILK

Proportion of ingredients

	WEIGHT IN GRAMS	APPROXIMATE MEASURE
Flour		
Pastry	180.0	1⅞ cup
or		
Family	180.0	1⅝ cup
Baking powder		
Tartrate	15.4	4 teaspoons
or		
Calcium-phosphate	16.0	4 teaspoons
or		
S.A.S.-phosphate	12.0	3 teaspoons
Sugar	25.0	2 tablespoons
Salt		½ teaspoon
Corn meal (yellow or white)	108.0	¾ cup
Egg	48.0	1 medium sized
Milk	244.0	237 cubic centimeters (1 cup)
Fat (melted or liquid fat)	40.0	3 tablespoons

Order of work: Detailed form

1. Assemble all ingredients and utensils needed in the preparation of the muffins. Oil the muffin tins.
2. Light the oven. Set it at 425° Fahrenheit if a tartrate or calcium-phosphate baking powder is to be used, or at 300° F. if a S.A.S.-phosphate powder is to be used.
3. (*a*) Weigh or measure the flour, baking powder, and sugar. Measure the salt. Mix these together; then sift them into the mixing bowl.

b) Weigh or measure the corn meal. Stir it into the mixture of flour, baking powder, sugar, and salt.
c) Beat the egg until it is foamy.
d) Weigh or measure the milk. Turn it into the egg.
e) Weigh or measure the fat. (If one of the solid fats is to be used, melt it before weighing or measuring.) Turn it into the egg-milk mixture.

4. Combine the wet and dry ingredients as follows:

   Just as soon as the fat has been poured into the egg and milk mixture, turn these wet ingredients into the dry ones all at one time, and immediately start to combine the two by stirring as *vigorously* as possible without spattering the mixture out of the bowl.

   If a tartrate powder has been used, stop stirring the instant the dry ingredients are *just dampened*. (This will probably take from 10 to 20 seconds.)

   If a calcium-phosphate or a S.A.S.-phosphate baking powder has been used, stir until the dry ingredients are just dampened, then for about 3 seconds longer (4 to 5 strokes.)

   Special care should be taken to avoid overstirring, for muffins are more easily ruined by this than by any other means. Just a few seconds of overbeating makes the muffin batter rise to peaks and be full of large holes.

   As soon as the beating-period is over, dip the batter into the muffin tins with as little stirring as possible. Fill each section about two-thirds full.

5. Bake the muffins as follows:

   If a tartrate or calcium-phosphate baking powder was used, bake at 425° F. until the crusts are golden brown (about 25 minutes). If a S.A.S.-phosphate powder was used, bake at 300° F. for about 5 minutes (or until the batter has risen to almost double its original height), then at 425° F. for about 20 minutes longer.

6. Remove the muffins from the tins immediately after taking them out of the oven, and serve them *at once*.

CORN-MEAL MUFFINS: SOUR MILK

If sour milk, freshly clabbered, is used instead of sweet milk, follow the recipe for sweet-milk corn-meal muffins except for the following changes:

1. Use 3 teaspoons (instead of 4) of tartrate or calcium-phosphate baking powder; 2 teaspoons (instead of 3) of S.A.S.-phosphate baking powder.

2. Use ½ teaspoon of soda and 1 tablespoon of water. Mix the two together, and stir into them the other wet ingredients.

CORN-MEAL MUFFINS: SWEET CREAM

Proportion of ingredients

	WEIGHT IN GRAMS	APPROXIMATE MEASURE
Flour		
Pastry	128.0	$1\frac{1}{3}$ cups
or		
Family	128.0	1 cup plus 2 tablespoons
Baking powder		
Tartrate	15.4	4 teaspoons
or		
Calcium-phosphate	16.0	4 teaspoons
or		
S.A.S.-phosphate	12.0	3 teaspoons
Sugar	25.0	2 tablespoons
Salt		½ teaspoon
Corn meal (yellow or white)	108.0	¾ cup
Egg	48.0	1 medium sized
Cream (18 per cent)	239.0	1 cup

Order of work: Detailed form

1. Assemble the ingredients and the utensils needed in the preparation of the muffins. Oil the tins.
2. Light the oven. Set it at 425° Fahrenheit if a tartrate or

calcium-phosphate baking powder is to be used, or at 300° F. if a S.A.S.-phosphate powder is to be used.

3. (*a*) Weigh or measure the flour, baking powder, and sugar. Measure the salt. Mix these together, then sift them into the mixing bowl.
   b) Weigh or measure the corn meal. Stir it into the mixture of flour, baking powder, sugar, and salt.
   c) Beat the egg until it is foamy.
   d) Weigh or measure the cream. Turn it into the egg.
4. Combine the wet and dry ingredients as follows:

   Turn the wet ingredients into the dry ones all at one time, and immediately start to combine the two by stirring as *vigorously* as possible without spattering the mixture out of the bowl.

   If a tartrate powder has been used, stop stirring the instant the dry ingredients are *just dampened.* (This probably will take from 10 to 20 seconds.)

   If a calcium-phosphate or a S.A.S.-phosphate baking powder has been used, stir until the dry ingredients are just dampened, then for about 3 seconds longer (4 to 5 strokes).

   Special care should be taken to avoid overstirring, for muffins are more easily ruined by this than by any other means. Just a few seconds of overbeating makes the muffin batter rise to peaks and be full of large holes.

   As soon as the beating-period is over, dip the batter into the muffin tins with as little stirring as possible. Fill each section about two-thirds full.
5. Bake the muffins as follows:

   If a tartrate or calcium-phosphate baking powder was used, bake at 425° F. until the crusts are golden brown (about 25 minutes). If a S.A.S.-phosphate powder was used, bake at 300° F. for about 5 minutes (or until the batter has risen to almost double its original height), then at 425° F. for about 20 minutes longer.
6. Remove the muffins from the tins immediately after taking them out of the oven, and serve them *at once.*

CORN-MEAL MUFFINS: SOUR CREAM

If freshly soured cream is used instead of sweet cream, follow the recipe for sweet-cream corn-meal muffins except for the following changes:

1. Use 3 teaspoons (instead of 4) of tartrate or calcium-phosphate baking powder; 2 teaspoons (instead of 3) of S.A.S.-phosphate baking powder.

2. Use $\frac{1}{2}$ teaspoon of soda and 1 tablespoon of water. Mix the two together and stir into them the other wet ingredients.

CHAPTER IV

CAKES CONTAINING FAT

The really excellent butter cake has a certain characteristic which is hard to describe and impossible to photograph. This, for want of a better word, we sometimes speak of as "velvetiness," meaning that to the tongue or fingers it has the feeling of soft velvet. Cakes which have this characteristic are always very light and of a fine, even grain, which is to say that they have small holes evenly distributed. But these qualities of lightness and evenness of texture do not insure the velvety feeling—both may be present and it lacking.

Not only the properties of this ideal cake, but also the procedure by which it may be obtained are difficult to describe. So far as we can judge from our present experience, the real problem is to get the ingredients finely divided and thoroughly combined to form a good stable emulsion without at the same time stirring out the carbon dioxide liberated from the baking powder.[1] Those of us who make mayonnaise—that is, salad dressing made by beating oil and some acid such as vinegar or lemon juice into egg yolk—know that not all methods of procedure are equally effective in combining the ingredients in such a way that they stay combined as a stable emulsion. And so it is with cakes. If the ingredients are put together in certain ways, they tend to separate: we lose our emulsion, and with it our velvety texture. In the pages that follow, we shall endeavor to describe the method which we have found successful. We may add that we have been to considerable trouble to find a simpler method which would give equally good results, but so far have not found one. Before going in detail into the subject of method of combining ingre-

[1] We have found that this process is most easily accomplished by moving the spoon around and around the bowl with a circular motion. When the movement is only fairly rapid as in dampening dry ingredients, we term it "stirring"; when it is fast, we call it "beating."

dients, or manipulation, there are one or two things to be said about ingredients.

INGREDIENTS

Flour.—In the products discussed up to this point, we have stated that, so far as we could see, the type of flour used made little, if any, difference, provided each was used in suitable proportion. With cakes, however, our experience has been different. We have been able to make the very best only with pastry flour, and not with all brands of it. This, of course, does not prove that flours other than those we have used, or indeed the very same ones, might not be used successfully under other conditions of work.

Three flours which have given us good results are Swans Down, Gold Medal, and Airy Fairy cake flours, and it is one of these that we recommend the beginner use for her first cakes. Once she has acquired the technique of cake-making, she may find it advisable to experiment with such brands of flour as are produced in her own vicinity, some of which, judging by our experience (page 42), will undoubtedly give excellent results.

Fats.—We prefer to use butter, or part butter, in cakes, simply for the added flavor it gives. The fats which we have used successfully along with butter are three hydrogenated ones—Snowdrift, Crisco, and one put out by Sprague Warner and Company under the Richelieu brand. All of these are tasteless and odorless and so plastic that they can be creamed easily. Two of them are even plastic when cold. The weight of a given measure of the three varies somewhat when solid, but is about the same—approximately 212 grams per cup—when melted. Measured in the solid condition, Crisco runs about 200, Snowdrift about 180, and the Sprague Warner product about 190 grams to the cup. We have used all of these fats interchangeably by weight with equally good results.

The approximate measure for hydrogenated fats in the cake recipes represents the value found for Crisco, the first fat of its type which we happened to use.

Eggs.—Attention should be called to the difference which exists in the size of eggs. This is so great that one large egg may

easily be the equivalent of two small ones. Thus, in the eggs shown in Figure 15 the smallest weighs 34, and the largest 70 grams in the shell, or about 30 and 62 grams without the shell. The weight chosen for one egg in our recipes is 48 grams after removing the shell, which is approximately the value accepted by home economics workers for a medium-sized egg. This weight is slightly less than the average of No. 1 eggs as graded for the city of Chicago market.

Weighing eggs in the shell and taking those which weigh about 55 grams is sufficiently accurate for ordinary purposes. If several eggs are used, there can be considerable variation in size and yet have the average around 55 grams. Weighing yolks and whites separately is a more accurate method and should be followed for experimental work. Without weighing, uniform results can be obtained only if one is a good guesser and can tell by the appearance of an egg whether it should be classed as large, small, or medium sized.

Any appreciable change in the quantity of egg used should be accompanied by an adjustment in the quantity of liquid, flour, and fat. What this adjustment should be we shall not attempt to say but will refer the reader to an article on the subject by Child.[1]

Sugar.—It is a little easier to obtain the good emulsion necessary for a velvety cake if we use finely, rather than coarsely, granulated sugar. Consequently, if the sugar one happens to have is coarse, it is advisable to make it fine by rolling it with the rolling-pin on the molding board.

MANIPULATION OF INGREDIENTS

Conventional method.—Our order of work for the velvety cake is the time-honored one, which is to cream the fat; add the sugar gradually; then the egg yolks; after that the flour, baking powder, and salt mixture alternately with the liquid, beginning and ending with the former; and finally to stir in the beaten whites. Following this order of work, however, does not necessarily make a good cake, as can be seen by examining those pictured in Figures 17,

[1] "Proportions of the Ingredients in Batters and Doughs," *Journal of Home Economics*, XVIII (1926), 157.

FIG. 15.—Eggs showing a common difference in size. The largest weighs more than twice as much as the smallest.

FIG. 16.—Wet (*A*) and dry (*B*) gluten from 25 grams of pastry flour; wet (*C*) and dry (*D*) gluten from 25 grams of family or general-purpose flour. Glutens from the two types of flour differ both in quantity and in quality.

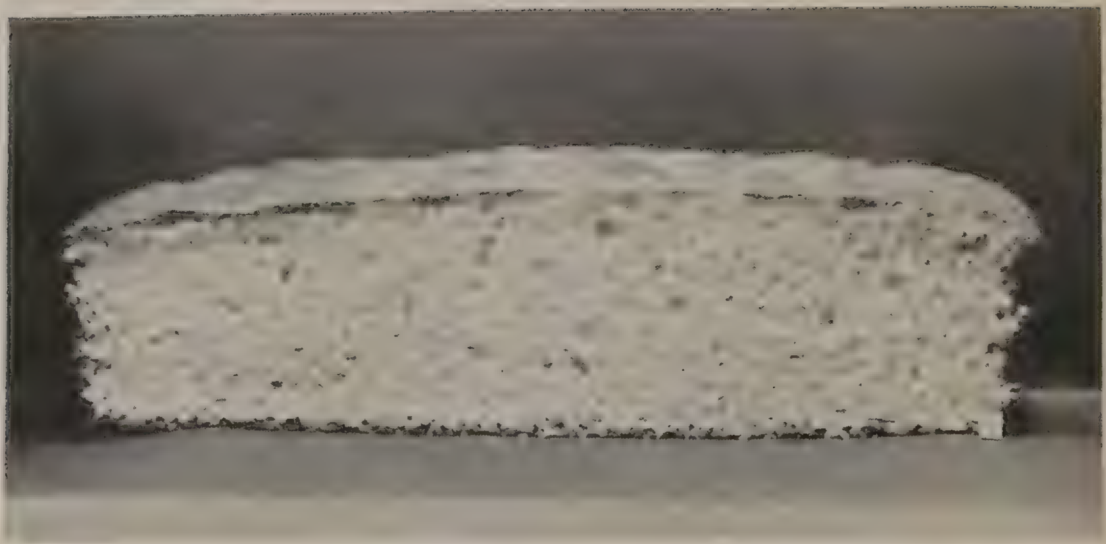


FIG. 17.—Cake in which the ingredients were thoroughly combined. The uniform thickness of the cake, its lightness, and even grain are noticeable.

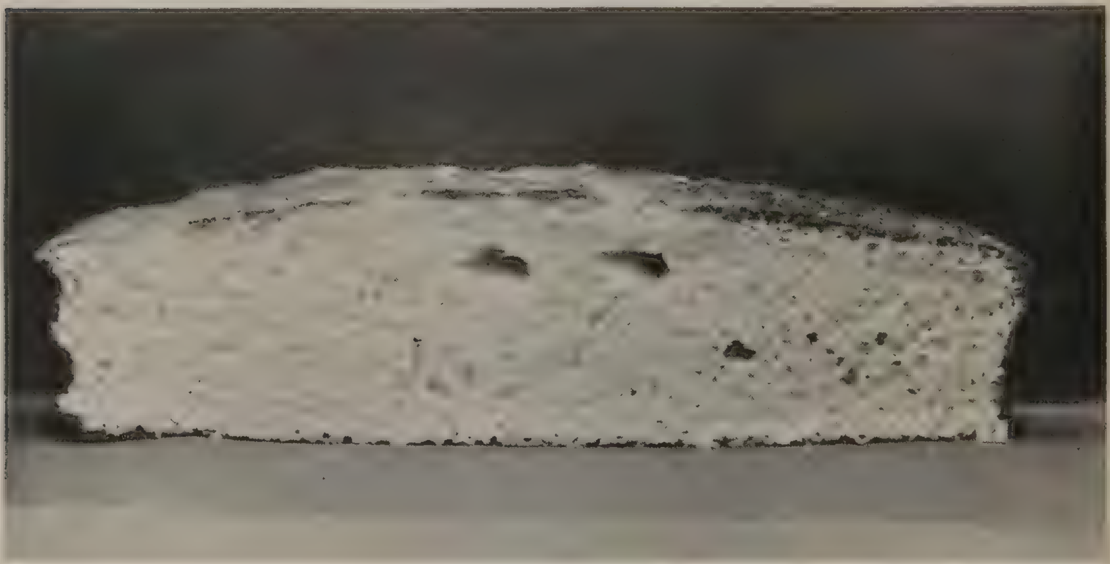


FIG. 18.—Cake in which the ingredients were not thoroughly combined. The rounded top, the soggy layer along the bottom and just beneath the crust, as well as the uneven grain, were much more prominent in the cake than the picture shows.

and 18.[1] Both of these were put together in the conventional order, and both were made by the same person from the same lot of ingredients. The only difference between the two was in the thoroughness of combining the ingredients. For the cake of Figure 18, the process was skimped a little at every point, as a consequence of which a good emulsion was not obtained and the resulting cake had a very poor texture and was of a smaller volume than the cake of Figure 17. The difference between the cakes was much more pronounced than the pictures show, the one being excellent, the other a failure.

At our speed of work it takes about 18 minutes to combine the ingredients—18 minutes of actual work, for when we stop to rest we take "time out." This means a good deal of beating, a large proportion of which must be done before the addition of milk, that is, in combining the fat, sugar, egg yolk, and first portion of flour.

We have not found that it made any decided difference to the final result where we put the emphasis in this preliminary beating provided we do some of it after adding the first portion of flour. In other words, if we skimp the beating at one part, say in creaming the fat, we can make up for it in another. It is much easier, however, to follow the usual procedure and beat thoroughly at each stage in the process rather than to postpone the beating until more of the ingredients are added and the mixture is harder to handle.

For our proportions and this particular method of work, we have not found it possible to obtain a good emulsion from melted fat. On the other hand, if the fat is too hard and solid to be plastic, we have not been able to get the desired type of emulsion. This means that in winter we let the fat stand out of the refrigerator for some time before we start working with it, and that on a hot summer day we sometimes put the whole mixture back into the refrigerator during the preliminary process, which is to say, up to and including the addition of the first proportion of the flour.

Up to this point, little delays do not matter; but from then on, the process should be continuous. This is because the baking

[1] Cakes made by Gladys Vail.

powder will start to react as soon as we begin to add the milk; hence, if we are exceedingly slow in our work, we may lose so much carbon dioxide that the cake will be heavy. And so after adding the first portion of milk we find it necessary to work continuously and quickly.

Furthermore, we find it advisable to add the flour and milk in small portions—alternating the two in such a way that flour comes last—and to beat the mixture vigorously after the addition of each portion of flour. This beating is important for it enables the flour to become thoroughly combined with the other ingredients, thus lessening the tendency of the mixture to separate and favoring the production of a velvety cake. The optimum beating time varies with the type of baking powder used; that which we have found most advantageous is given in each recipe.[1]

Finally, we stir in the beaten whites as quickly as we can. Speed here appears to be more important than gentleness of movement, which counts for so much in angel food and sponge cakes (page 95). In the latter the batters are sufficiently viscous, owing to the large proportion of egg, to hold in the air—which makes the cakes light—if we handle them with care. When fewer whites are used, as in the type of cake we are now considering, the mixture is less viscous and tends to lose considerable gas on stirring, no matter how gently we handle it. Since gas is continually forming from the baking powder, this loss in stirring is compensated for if we do not prolong the process until the gas-producing power of the baking powder is reduced too low to furnish enough for lightness. This an experienced worker is not at all likely to do; but an inexperienced one may, particularly a hard-working, conscientious person. On the other hand, the egg white must be thoroughly combined; otherwise the cake will be coarse. We have our best results when we stir at such a rate as to get a good smooth batter, with no flakes of egg white showing, in about 25 seconds.

The instant we finish stirring we turn the cake into the pan, and we bake it immediately or some time later as happens to be

[1] Recent experiments (Aug. 1928) indicate that in very hot, damp weather the beating times given in the recipes should be reduced about half.

convenient. We find that it makes no difference which we do—that cakes which have stood for a short time before baking are quite as good as those baked as soon as they are put into the pan. For purposes of experiment we have even allowed them to stand, covered with a cake pan, for as long as 3 hours in the refrigerator without being able to detect any change in their quality.

Muffin method.[1]—While the ideal cake appears to require quite a bit of work, a fair one (by which we mean one which is light and of good flavor, but lacking in the velvety quality) can be made from certain recipes with very little work. Moreover, the process by which this fairly good cake can be made is so simple that a beginner can usually make about as good cake at the first trial as on later ones. The recipes given here which lend themselves to this easy method are Plain Cakes I and II, and the Spice Cake (pages 71, 76, 80). We use the same method as for muffins, save that we beat the batter longer at the end of the combining period; and when a tartrate baking powder is used, we add the egg whites beaten separately at the last, as in the conventional method.

We bake these cakes in muffin tins and serve them while warm. If any are left over, we re-warm them before serving again. To do this we sprinkle them with cold water, replace in the muffin tins, and heat in a hot oven—about 400° Fahrenheit—until the water sprinkled over them has evaporated and they are warmed through.

One precaution should be taken in using the muffin method for cakes, and that is to avoid having the melted fat extremely hot—or worse yet, almost cold. Fats can reach a very high temperature, some of them well over 400° F., before they begin to smoke and thus give visible evidence of their decomposition. This accounts for the fact that they are frequently allowed to become very hot when put over the fire to melt. An extremely hot fat warms up the whole mixture and consequently hastens the reaction of the baking powder, perhaps with disastrous results. On the other hand a cool fat may solidify almost as soon as it strikes the cold milk; this is particularly true for some of the plastic

[1] Recent experiments (Aug. 1928) indicate that this method is not successful in very hot, damp weather.

hydrogenated ones. In a solid condition, the fat does not mix well with the other ingredients by this method of work, and therefore the cake will be coarse and granular.

The kind of cake one decides to make will depend, for one thing, on the time at one's disposal and, for another, on how long after baking one expects to serve it. A cake which served fresh from the oven seems good, may perhaps be very poor if kept 24 hours or even less. The cake with the stable emulsion will retain its freshness for a longer period than will the fairly good one, even though the two are made from exactly the same ingredients in precisely the same proportions. The reason for this appears to be that the quality of staleness is not altogether a matter of dryness (in other words, actual loss of water) but is partly a question of the distribution of the water[1] among the different components of the mixture. When cakes or other baked products cool, the water tends to distribute itself in such a way as to make for staleness, a tendency which appears to be checked if the ingredients are really in the form of a stable emulsion, which is the condition existing in our velvety cake.

UTENSILS

a) Mixing bowl: The amounts of batter for the different cakes made with fat are so nearly alike that all may be made in the same-sized bowl, preferably one having a capacity of 2 quarts and shaped like that shown in Figure 7, facing page 42.

b) Baking pans: In baking these cakes, pans of different sizes are required, each of such a volume that the cake will completely fill it when fully risen, but will have no tendency to bulge over the rim.

At the head of each recipe we have given the total capacity of the baking pans needed, and also the actual dimensions of the ones we use in this laboratory and therefore the ones for which our baking periods were worked out. These periods will, of course, have to be increased somewhat for deeper pans and decreased for shallower ones.

[1] J. R. Katz, "Das Altbackenwerden der Brotkrume vom physiologischcemischen Standpunkte betrahtet," *Zeitschrift für Physiologische Chemie*, XCV (1915) 104.

We prefer baking pans no more than 1½ inches deep.

BAKING

a) Temperature: Two baking temperatures are given for each cake, a lower one to allow the cake to rise to double its original height, a higher one to complete the baking.

b) Tests: To make sure that a cake is sufficiently baked, we advise the beginner to use the good old-fashioned toothpick test. This is simply to run a toothpick into the center of the cake, pull it out, and note whether it comes out clean without any particles of dough sticking to it. A clean toothpick means a completely baked cake. The experienced cake-maker judges that a cake is done when it shrinks slightly from the sides of the pan and is not dented in the center when touched lightly with the finger.

No test should, of course, be made until the cake has baked for approximately the length of time specified in the directions for baking.

DIRECTIONS FOR THE PREPARATION OF CAKES CONTAINING FAT

Before attempting to use these recipes, read the preceding discussion of cakes and the section on weighing and measuring (page 26).

PLAIN CAKE I

Yield

As a two-layer cake: 10 "pie-shaped" pieces, 2¼ inches across the outer edge; as a loaf cake: 16 pieces, 2 inches by 2 inches by 1½ inches; as cup cakes: 16 cup cakes, 2½ inches in diameter and 1¼ inches high.

Baking pans

Capacity: 1,600 to 1,700 cubic centimeters (about 7 cups).

Pans used in this laboratory:

a) Two layer-cake pans, 8½ inches in diameter by 1 inch high.

b) One loaf-cake pan, 8¼ inches by 8¼ inches by 1½ inches.

c) Sixteen muffin-pan sections each of 100 cubic centimeter capacity.

Proportion of ingredients

	WEIGHT IN GRAMS	APPROXIMATE MEASURE
Butter	70.0	$\frac{1}{3}$ cup
or		
Butter	35.0	$2\frac{2}{3}$ tablespoons
and		
Hydrogenated fat	33.8	$2\frac{2}{3}$ tablespoons
Sugar	200.0	1 cup
Eggs		
Yolks	36.0	2 medium sized
Whites	60.0	2 medium sized
Cake flour	174.0	$1\frac{3}{4}$ cup plus 1 tablespoon
Baking powder		
Tartrate	9.6	$2\frac{1}{2}$ teaspoons
or		
Calcium-phosphate	10.0	$2\frac{1}{2}$ teaspoons
or		
S.A.S.-phosphate	8.0	2 teaspoons
Salt		$\frac{1}{4}$ teaspoon
Milk	162.7	158 cubic centimeters ($\frac{2}{3}$ cup)
Vanilla		$\frac{1}{2}$ teaspoon

Conventional method: Order of work: Detailed form

1. Assemble all ingredients and utensils needed in the preparation of the cake.

   Fit a piece of light-weight oiled or other thin paper into the bottom of the pan; oil the paper and the sides of the pan.

2. (*a*) Weigh or measure the fat. Place it in the mixing bowl. If the room is very hot (90° Fahrenheit or above), set the fat in a refrigerator until the rest of the ingredients are ready.

   b) Weigh or measure the sugar.

c) Weigh or measure the flour and baking powder. Measure the salt. Mix the three well; then sift them together.

d) Weigh or measure the milk.

e) Measure the vanilla. Turn it into the milk.

3. Light the oven. Set it at 350° F. for a tartrate or calcium-phosphate baking powder; at 300° F. for a S.A.S.-phosphate baking powder.

4. Combine the fat, sugar, and egg yolks as follows:

a) Cream the fat with a wooden spoon until it is very plastic and a light-yellow color.

b) Add a little (about 1 tablespoon) of the sugar to the fat and beat until the mixture looks fluffy (this will take about 1 minute). Repeat until all the sugar is mixed with the fat. When this has been done, the resulting product should be a light-yellow, fluffy mixture of thoroughly blended fat and sugar, having the general appearance of hard sauce. Remove all material clinging to the spoon. If the room is hot, set the creamed fat and sugar in a refrigerator while the eggs are being separated and the whites beaten.

c) Separate the egg whites from the yolks; place the yolks in the fat-sugar mixture and the whites in a bowl in which they can be beaten conveniently. Beat the whites until they are stiff but not until they lose their shiny appearance.

d) Beat the egg yolks with the fat and sugar until they are thoroughly combined (30 seconds or more).

5. Combine the remaining ingredients as follows:

a) Add about one-sixth, approximately 4 tablespoons, of the mixture of flour, baking powder, and salt to the fat-sugar-egg mixture. Stir until the flour is dampened, (about 10 seconds), then beat for 30 seconds.

The mixing process should be continuous from now until the batter is in the pan. Therefore, be sure that everything needed is at hand.

b) Add about one-fifth, approximately 2 tablespoons, of the milk. With a few gentle strokes mix it slightly (not thoroughly) with the other ingredients.

c) Repeat this addition of flour and milk alternately, using the same amounts and the same method of combination as given above, except shorten the beating-period after the dampening of the flour to 10 seconds.

End with a portion of flour.

The total time required for steps (*b*) and (*c*) is about 6 minutes.

d) When all the flour has been added and the last portion dampened, beat the batter for 15 seconds if a tartrate, for 30 seconds if a calcium-phosphate, or for 1 minute if a S.A.S.-phosphate baking powder has been used.

e) Add the beaten whites and stir gently but quickly until the mixture can be beaten without spattering—about 5 seconds. Then beat for 25 seconds. Immediately turn the batter into the oiled tins.

6. Bake[1] the cake as follows:
   a) For a tartrate or calcium-phosphate baking powder:
   (1) Layer cake—at 350° F. during the first 10 minutes, then at 375° F. for about 20 minutes longer.
   (2) Loaf cake—at 350° F. during the first 20 minutes, then at 375° for about 20 minutes longer.
   (3) Cup cakes—at 350° F. during the first 10 minutes, then at 375° F. for about 15 minutes longer.
   b) For a S.A.S.-phosphate baking powder:
   (1) Layer cake—at 300° F. during the first 10 minutes, then at 375° F. for about 25 minutes longer.
   (2) Loaf cake—at 300° F. during the first 20 minutes, then at 375° F. for about 25 minutes longer.
   (3) Cup cakes—at 300° F. during the first 10 minutes, then at 375° F. for about 15 minutes longer.
7. As soon as the cake is taken from the oven, remove it from the tin and take the paper off the bottom. Place the cake on a rack to cool.

[1] Baking tests are given on page 71.

Conventional method: Order of work: Abbreviated form

If the person who is to make the cake chooses to use butter for the fat, to use a S.A.S.-phosphate baking powder, to weigh the troublesome ingredients, to bake as a layer cake, and if the room is cool, a résumé of the recipe is somewhat as follows:

1. Weigh or measure the ingredients:

Butter	70.0	grams
Sugar	200.0	grams
Flour	174.0	grams
Baking powder	2	teaspoons
Salt	$\frac{1}{4}$	teaspoon
Milk	158	cubic centimeters ($\frac{2}{3}$ cup)
Vanilla	$\frac{1}{2}$	teaspoon

2. Light oven (300° F.).
3. Cream fat and sugar (5 minutes or more).
4. Separate egg whites and yolks; use 2 whites (60 grams) and 2 yolks (36 grams); beat whites.
5. Beat yolks with fat and sugar (30 seconds or more).
6. Add flour and milk alternately, beginning and ending with flour.

   Flour should be beaten in; milk only partialy mixed.
7. After adding the last portion of flour, beat 1 minute.
8. Stir in beaten egg whites, then beat 25 seconds.
9. Bake 10 minutes at 300° F., then 25 minutes at 375° F.

Muffin method: Order of work

1. Assemble all ingredients and utensils needed in the preparation of the cake. Oil the baking pans—muffin tins are to be preferred.
2. Weigh or measure the ingredients:

   Flour
   Baking powder
   Sugar
   Salt
   } Mix, then sift together into the mixing bowl

   Egg: For a S.A.S.-phosphate or a calcium-phosphate baking powder, beat the yolks and whites together until

foamy; for a tartrate baking powder, beat the yolks and whites separately, the whites until they are stiff.

Milk, Vanilla: Turn into the whole egg, or into the egg yolks if the whites and yolks were beaten separately.

Butter: Melt before weighing or measuring. After weighing or measuring, turn into the egg-milk-vanilla mixture.

3. Combine the wet and dry ingredients as follows:
   a) Make a well in the center of the dry ingredients.
   b) If a S.A.S.-phosphate or calcium-phosphate baking powder was used, turn all the wet ingredients into the well and stir as vigorously as possible until the batter can be beaten without spattering (about 20 seconds). Then beat for 1 minute.

      If a tartrate baking powder was used, turn all the wet ingredients into the well and stir as vigorously as possible until the batter can be beaten without spattering. Beat for 15 seconds; stir in the beaten egg whites and continue beating for 25 seconds.
4. Bake (in muffin pans) at 300° F. for the first 10 minutes, then at 375° F. for about 15 minutes longer if a S.A.S.-phosphate baking powder was used; at 350° F. for the first 10 minutes, then at 375° F. for about 15 minutes longer, if a tartrate or calcium-phosphate baking powder was used.
5. Remove from the tins as soon as taken from the oven. Serve while warm.

PLAIN CAKE II[1]

Yield

As a loaf cake: 9 pieces, 2 inches by 2 inches by 1½ inches; as cup cakes: 11 cup cakes, 2½ inches in diameter and 1¼ inches high.

Baking pans

Capacity: 1,100 to 1,200 cubic centimeters (approximately 5 cups).

Pans used in this laboratory:

a) One loaf-cake pan 6½ inches by 6½ inches by 1½ inches.

[1] This cake is a particularly nice modification of Plain Cake I.

b) Eleven muffin-pan sections each of 100 cubic centimeter capacity.

Proportion of ingredients

	WEIGHT IN GRAMS	APPROXIMATE MEASURE
Butter	52.5	¼ cup
or		
Butter	26.3	2 tablespoons
and		
Hydrogenated fat	25.4	2 tablespoons
Sugar	150.0	¾ cup
Eggs		
Yolk	18.0	1 medium sized
Whites	60.0	2 medium sized
Cake flour	128.0	1⅓ cups
Baking powder		
Tartrate	7.7	2 teaspoons
or		
Calcium phosphate	8.0	2 teaspoons
or		
S.A.S.-phosphate	6.0	1½ teaspoons
Salt		¼ teaspoon
Milk	122.0	118 cubic centimeters (½ cup)
Vanilla		½ teaspoon

Conventional method: Order of work: Detailed form

1. Assemble all ingredients and utensils needed in the preparation of the cake.

   Fit a piece of light-weight oiled or other thin paper into the bottom of the pan; oil the paper and the sides of the pan.

2. (*a*) Weigh or measure the fat. Place it in the mixing bowl. If the room is very hot (90 degrees Fahrenheit or above), set the fat in the refrigerator until the rest of the ingredients are ready.

   b) Weigh or measure the sugar.

c) Weigh or measure the flour and baking powder. Measure the salt. Mix the three well; then sift them together.

d) Weigh or measure the milk.

e) Measure the vanilla; turn it into the milk.

3. Light the oven. Set it at 350° F. for a tartrate or a calcium-phosphate baking powder; at 300° F. for a S.A.S.-phosphate baking powder.

4. Combine the fat, sugar, and egg yolk as follows:

a) Cream the fat with a wooden spoon until it is very plastic and a light-yellow color.

b) Add a little (about 1 tablespoon) of the sugar to the fat and beat until the mixture looks fluffy (this will take about 1 minute). Repeat until all the sugar is mixed with the fat. When this has been done, the resulting product should be a light-yellow, fluffy mixture of thoroughly blended fat and sugar, having the general appearance of hard sauce. Remove all material clinging to the spoon. If the room is hot, set the creamed fat and sugar in the refrigerator while the eggs are being separated and the whites beaten.

c) Separate the egg whites from the yolks; place one of the yolks in the fat-sugar mixture, and the whites in a bowl in which they can be beaten conveniently. Beat the whites until they are stiff but not until they lose their shiny appearance.

d) Beat the egg yolk with the fat and sugar until the three are thoroughly combined (30 seconds or more).

5. Combine the remaining ingredients as follows:

a) Add about one-fifth, approximately 4 tablespoons, of the mixture of flour, baking powder, and salt to the fat-sugar-egg mixture.

Stir until the flour is dampened (about 10 seconds); then beat for 30 seconds.

The mixing process should be continuous from now until the batter is in the pan. Therefore, be sure that everything needed is at hand.

b) Add about one-fourth, approximately 2 tablespoons, of the milk. With a few gentle strokes of the spoon mix it slightly (not thoroughly) with the other ingredients.

c) Repeat this addition of flour and milk alternately, using the same amounts and the same method of combination as given above, except shorten the beating-period after the dampening of the flour to 10 seconds.

End with a portion of flour.

The total time required for steps (*b*) and (*c*) is about 5 minutes.

d) When all the flour has been added and the last portion dampened, beat the batter for 15 seconds if a tartrate, for 30 seconds if a calcium-phosphate, or for 1 minute if a S.A.S.-phosphate baking powder has been used.

e) Add the beaten egg whites and stir gently but quickly until the mixture can be beaten without spattering (about 5 seconds). Then beat for 25 seconds. Immediately turn the batter into the oiled tins.

6. Bake[1] the cake as follows:
   a) For a tartrate or calcium-phosphate baking powder:
      (1) Loaf cake—at 350° F. during the first 20 minutes, then at 375° F. for about 20 minutes longer.
      (2) Cup cakes—at 350° F. during the first 10 minutes, then at 375° F. for about 15 minutes longer.
   b) For a S.A.S.-phosphate baking powder:
      (1) Loaf cake—At 300° F. during the first 20 minutes, then at 375° F. for about 25 minutes longer.
      (2) Cup cakes—at 300° F. during the first 10 minutes, then at 375° F. for about 15 minutes longer.
7. As soon as the cake is taken from the oven, remove it from the pan and take the paper off the bottom. Place the cake on a rack to cool.

Muffin method

The muffin method of combining the ingredients for this cake is exactly like that for Plain Cake I (page 75).

[1] Baking tests are given on page 71.

SPICE CAKE

Yield

As a loaf cake: 9 pieces, 2 inches by 2 inches by 1½ inches; as cup cakes: 11 cup cakes, 2½ inches in diameter and 1¼ inches high.

Baking pans

Capacity: 1,100 to 1,200 cubic centimeters (approximately 5 cups).

Pans used in this laboratory:

a) One loaf-cake pan 6½ inches by 6½ inches by 1½ inches.

b) Eleven muffin-pan sections each of 100 cubic centimeter capacity.

Proportion of ingredients

	WEIGHT IN GRAMS	APPROXIMATE MEASURE
Butter	52.5	¼ cup
or		
Butter	26.3	2 tablespoons
and		
Hydrogenated fat	25.4	2 tablespoons
Sugar	150.0	¾ cup
Eggs		
Yolks	36.0	2 medium sized
Whites	30.0	1 medium sized
Cake flour	128.0	1⅓ cup
Baking powder		
Tartrate	7.7	2 teaspoons
or		
Calcium-phosphate	8.0	2 teaspoons
or		
S.A.S.-phosphate	6.0	1½ teaspoons
Salt		¼ teaspoon
Milk	122.0	118 cubic centimeters (½ cup)
Cinnamon		1 teaspoon

Proportion of ingredients—*Continued*

	WEIGHT IN GRAMS	APPROXIMATE MEASURE
Cloves, allspice, nutmeg..........		½ teaspoon each
or, in place of the above spices, spice mixture[1]..........		2 teaspoons
Boiling water....................		1 tablespoon

Conventional method: Order of work: Detailed form

1. Assemble all ingredients and utensils needed in the preparation of the cake.

   Fit a piece of light-weight oiled or other thin paper into the bottom of the pan; oil the paper and the sides of the pan.

2. (*a*) Weigh or measure the fat. Place it in the mixing bowl. If the room is very hot (90° F. or above), set the fat in a refrigerator until the rest of the ingredients are ready.
   b) Weigh or measure the sugar.
   c) Weigh or measure the flour and baking powder. Measure the salt. Mix the three well; then sift them together.
   d) Weigh or measure the milk.
   e) Measure the vanilla. Turn it into the milk.

3. Light the oven. Set it at 350° F. for a tartrate or a calcium-phosphate baking powder; at 300° F. for a S.A.S.-phosphate baking powder.

4. Combine the fat, sugar, and egg yolks as follows:
   a) Cream the fat with a wooden spoon until it is very plastic and a light-yellow color.
   b) Add a little (about 1 tablespoon) of the sugar to the fat and beat until the mixture looks fluffy (this will take about 1 minute). Repeat until all the sugar is mixed

[1] We have found it very convenient and time-saving to prepare at one time a fairly large quantity of a mixture of spices which can be used in the preparation of this cake and also of gingerbread. This is made by mixing together thoroughly two parts by measure of ground cinnamon, and one part each of ground cloves, allspice, and nutmeg. The mixture should be kept in a practically air-tight container, such as a jelly glass with a tightly fitting lid.

with the fat. When this has been done, the resulting product should be a light-yellow, fluffy mixture of thoroughly blended fat and sugar, having the general appearance of hard sauce. Remove all material clinging to the spoon. If the room is hot, set the creamed fat and sugar in a refrigerator while the eggs are being separated and the whites beaten.

c) Separate the egg whites from the yolks; place the yolks in the fat-sugar mixture, and one of the whites in a bowl in which it can be beaten conveniently. Beat the white until it is stiff but not until it loses its shiny appearance.

d) Beat the egg yolks with the fat and sugar until they are thoroughly combined (30 seconds or more).

5. Combine the remaining ingredients as follows:

a) Put a small quantity of water on the fire to boil; measure the spices; measure the boiling water, and mix with the spices.

b) Beat the moistened spices with the fat-sugar-egg-yolk mixture until they are thoroughly combined (about 30 seconds).

c) Add about one-fifth, approximately 4 tablespoons, of the mixture of flour, baking powder, and salt. Stir until the flour is dampened (about 10 seconds), then beat for 30 seconds.

The mixing process should be continuous from now until the batter is in the pan. Therefore, be sure that everything needed is at hand.

d) Add about one-fourth, approximately 2 tablespoons, of the milk. With a few gentle strokes of the spoon mix it slightly (not thoroughly) with the other ingredients.

e) Repeat this addition of flour and milk alternately, using the same amounts and the same method of combination as given above, except shorten the beating-period after the dampening of the flour to 10 seconds.

End with a portion of flour.

The total time required for steps (*d*) and (*e*) is about 5 minutes.

f) When all the flour has been added and the last portion dampened, beat the batter for 15 seconds if a tartrate, for 30 seconds if a calcium-phosphate, or for 1 minute if a S.A.S.-phosphate baking powder has been used.

g) Add the beaten egg white and stir gently but quickly until the mixture can be beaten without spattering (about 5 seconds). Then beat for 25 seconds. Immediately turn the batter into the oiled tins.

6. Bake[1] the cake as follows:
   a) For a tartrate or calcium-phosphate baking powder:
   (1) Loaf cake—at 350° F. during the first 20 minutes, then at 375° F. for about 20 minutes longer.
   (2) Cup cakes—at 350° F. during the first 10 minutes, then at 375° F. for about 15 minutes longer.
   b) For a S.A.S.-phosphate baking powder:
   (1) Loaf cake—at 300° F. during the first 20 minutes, then at 375° F. for about 25 minutes longer.
   (2) Cup cakes—at 300° F. during the first 10 minutes, then at 375° F. for about 15 minutes longer.
7. As soon as the cake is taken from the oven, remove it from the pan and take the paper off the bottom. Place it on a cake rack to cool.

Muffin method: Order of work

1. Assemble all ingredients and utensils needed in the preparation of the cake. Oil the baking pans—muffin tins are to be preferred.
2. Weigh or measure the ingredients:

Flour Baking powder Sugar Salt	Mix, then sift together into the mixing bowl
Spices Boiling water	Mix together
Eggs:	For a S.A.S.-phosphate or a calcium-phosphate baking powder, beat the yolks and white together

[1] Baking tests given on page 71.

until foamy; for a tartrate baking powder, beat the yolks and white separately, the white until it is stiff.

Milk: Turn into the egg, or into the egg yolks if the white and yolks were beaten separately.

Butter: Melt before weighing or measuring. After weighing or measuring, turn into the egg-milk mixture.

3. Combine the wet and dry ingredients as follows:
   a) Make a well in the center of the dry ingredients.
   b) If a S.A.S.-phosphate or calcium-phosphate baking powder was used, turn all the wet ingredients and the moist spices into the well and stir as vigorously as possible until the batter can be beaten without spattering (about 20 seconds). Then beat for 1 minute.

   If a tartrate baking powder was used, turn all the wet ingredients and the moist spices into the well and stir as vigorously as possible until the batter can be beaten without spattering. Then beat for 15 seconds; stir in the beaten egg white and continue beating for 25 seconds.
4. Bake (in muffin pans) at 300° F. for the first 10 minutes, then at 375° F. for about 15 minutes longer if a S.A.S.-phosphate baking powder was used; at 350° F. for the first 10 minutes, then at 375° F. for about 15 minutes longer if a tartrate or calcium-phosphate baking powder was used.
5. Remove from the tins as soon as taken from the oven. Serve while warm.

CHOCOLATE CAKE

Yield

As a two-layer cake: 10 "pie-shaped" pieces, 2¼ inches across the outer edge; as a loaf cake: 16 pieces, 2 inches by 2 inches by 1½ inches; as cup cakes: 16 cup cakes, 2½ inches in diameter and 1¼ inches high.

Baking pans

Capacity: 1,600 to 1,700 cubic centimeters (approximately 7 cups).

Pans used in this laboratory:

a) Two layer-cake pans, $8\frac{1}{2}$ inches in diameter by 1 inch high.
b) One loaf-cake pan, $8\frac{1}{4}$ inches by $8\frac{1}{4}$ inches by $1\frac{1}{2}$ inches.
c) Sixteen muffin-tin sections, each of 100 cubic centimeter capacity.

Proportion of ingredients

	WEIGHT IN GRAMS	APPROXIMATE MEASURE
Bitter chocolate	56.7	2 squares
Butter	52.5	$\frac{1}{4}$ cup
or		
Butter	26.3	2 tablespoons
and		
Hydrogenated fat	25.4	2 tablespoons
Sugar	200.0	1 cup
Eggs		
Yolks	36.0	2 medium sized
Whites	60.0	2 medium sized
Cake flour	128.0	$1\frac{1}{3}$ cups
Baking powder		
Tartrate	7.7	2 teaspoons
or		
Calcium-phosphate	8.0	2 teaspoons
or		
S.A.S.-phosphate	6.0	$1\frac{1}{2}$ teaspoons
Salt		$\frac{1}{4}$ teaspoon
Milk	183.0	178 cubic centimeters ($\frac{3}{4}$ cup)
Vanilla		$\frac{1}{2}$ teaspoon

Conventional method: Order of work: Detailed form

1. Assemble all ingredients and utensils needed in the preparation of the cake.

   Fit a piece of light-weight oiled or other thin paper into the bottom of the pan; oil the paper and the sides of the pan.

2. (*a*) Weigh or measure the chocolate. Place it in a pan from which the melted chocolate can be removed easily (a very shallow pan which has a handle is most conven-

ient), and melt it over hot water. While it is melting, other ingredients may be weighed; but as soon as all of it has melted, it should be removed from the heat and allowed to cool somewhat before using.

b) Weigh or measure the fat. Place it in the mixing bowl. If the room is very hot (90° Fahrenheit or above), set the fat in the refrigerator until the rest of the ingredients are ready.

c) Weigh or measure the sugar.

d) Weigh or measure the flour and baking powder. Measure the salt. Mix the three well; then sift them together.

e) Weigh or measure the milk.

f) Measure the vanilla. Turn it into the milk.

3. Light the oven. Set it at 350° F. for a tartrate or a calcium-phosphate baking powder, at 300° F. for a S.A.S.-phosphate baking powder.

4. Combine the fat, sugar, and egg yolks as follows:

a) Cream the fat with a wooden spoon until it is very plastic and a light-yellow color.

b) Add a little (about 1 tablespoon) of the sugar to the fat and beat until the mixture looks fluffy (this will take about 1 minute). Repeat until all the sugar is mixed with the fat.

Remove all material clinging to the spoon.

If the room is hot, set the creamed fat and sugar in the refrigerator while the eggs are being separated and the whites beaten.

c) Separate the egg whites from the yolks; place the yolks in the fat-sugar mixture, and the whites in a bowl in which they can be beaten conveniently. Beat the whites until they are stiff, but not until they lose their shiny appearance.

d) Beat the egg yolks with the fat and sugar until they are thoroughly combined (30 seconds or more).

5. Combine the remaining ingredients as follows:

a) Add the melted chocolate to the mixture of fat, sugar,

and egg yolks, and beat until it is thoroughly combined with them (30 seconds or more).

b) Add about one-fifth, approximately 4 tablespoons, of the mixture of flour, baking powder, and salt to the mixture of fat, sugar, egg yolks, and chocolate. Stir until the flour is dampened (about 10 seconds); then beat for 30 seconds.

The mixing process should be continuous from now until the batter is in the pan. Therefore, be sure that everything needed is at hand.

c) Add about one-fourth, approximately 3 tablespoons, of the milk. With a few gentle strokes mix it slightly (not thoroughly) with the other ingredients.

d) Repeat this addition of flour and milk alternately, using the same amounts and the same method of combination as given above, except shorten the beating-period after the dampening of the flour to 10 seconds. End with a portion of flour.

The total time required for steps (*c*) and (*d*) is about 5 minutes.

e) When all the flour has been added and the last portion dampened, beat the batter for 15 seconds if a tartrate, for 30 seconds if a calcium-phosphate, or for 1 minute if a S.A.S.-phosphate baking powder has been used.

f) Add the beaten whites, and stir gently but quickly until the mixture can be beaten without spattering—about 5 seconds. Then beat for 25 seconds.

g) Immediately turn the batter into the oiled tins.

6. Bake[1] the cake as follows:

a) For a tartrate or calcium-phosphate baking powder:

(1) Layer cake—at 350° F. for about 35 minutes.

(2) Loaf cake—at 350° F. for about 45 minutes.

(3) Cup cakes—at 350° F. for about 30 minutes.

b) For a S.A.S.-phosphate baking powder:

(1) Layer cake—at 300° F. during the first 10 minutes, then at 350° for about 25 minutes longer.

[1] Baking tests are given on page 71.

(2) Loaf cake—at 300° F. during the first 20 minutes, then at 350° F. for about 25 minutes longer.
(3) Cup cakes—at 300° F. during the first 10 minutes, then at 350° F. for about 20 minutes longer.

7. As soon as the cake is taken from the oven, remove it from the pan and take the paper off the bottom. Place the cake on a rack to cool.

WHITE CAKE

Yield

As a two-layer cake: 10 "pie-shaped" sections, 2¼ inches across the outer edge; as a loaf cake: 16 pieces, 2 inches by 2 inches by 1½ inches.

Baking pans

Capacity: 1,700 cubic centimeters (approximately 7 cups).

Pans used in this laboratory:

a) Two layer-cake pans, 8½ inches in diameter by 1 inch high.
b) One loaf-cake pan, 8¼ inches by 8¼ inches by 1½ inches.

Proportion of ingredients

	WEIGHT IN GRAMS	APPROXIMATE MEASURE
Butter	52.5	¼ cup
Hydrogenated fat	50.8	¼ cup
Sugar	200.0	1 cup
Egg whites	114.0	½ cup (whites from about 4 medium-sized eggs)
Cake flour	168.0	1¾ cup
Baking powder		
Tartrate	15.4	4 teaspoons
or		
Calcium-phosphate	16.0	4 teaspoons
or		
S.A.S.-phosphate	12.0	3 teaspoons
Salt		¼ teaspoon
Milk	122.0	118 cubic centimeters (½ cup)
Lemon extract		1 teaspoon
Almond extract		½ teaspoon

Conventional method: Order of work: Detailed form

1. Assemble all ingredients and utensils needed in the preparation of the cake.

   Fit a piece of light-weight oiled or other thin paper into the bottom of the pan; oil the paper and the sides of the pan.

2. (*a*) Weigh or measure the fat. Place it in the mixing bowl. If the room is very hot (90° Fahrenheit or above), set the fat in the refrigerator until the rest of the ingredients are ready.

   b) Weigh or measure the sugar.

   c) Weigh or measure the flour and baking powder. Measure the salt. Mix the three well; then sift them together.

   d) Weigh or measure the milk.

   e) Measure the lemon and almond extracts. Turn them into the milk.

3. Light the oven. Set it at 350° F. for a tartrate or calcium-phosphate baking powder, at 300° F. for a S.A.S.-phosphate baking powder.

4. Combine the fat and sugar as follows:

   a) Cream the fat with a wooden spoon until it is very plastic and a light-yellow color.

   b) Add a little (about 1 tablespoon) of the sugar to the fat and beat until the mixture looks fluffy (this will take about 1 minute). Repeat until all the sugar is mixed with the fat. When this has been done, the resulting product should be a light-yellow, fluffy mixture of thoroughly blended fat and sugar, having the general appearance of hard sauce.

   Remove all material clinging to the spoon.

   If the room is hot, set the creamed fat and sugar into the refrigerator while the eggs are being separated and the whites beaten.

5. Separate the egg whites from the yolks; weigh or measure them; place them in a bowl in which they can be beaten conveniently and beat them until they are stiff but not until they lose their shiny appearance.

6. Combine the remaining ingredients as follows:
   a) Add about one-sixth, approximately 4 tablespoons, of the mixture of flour, baking powder, and salt to the fat-sugar mixture. Stir until the flour is dampened (about 10 seconds); then beat for 30 seconds.

   The mixing process should be continuous from now until the batter is in the pan. Therefore, be sure that everything needed is at hand.

   b) Add about one-fifth, approximately $1\frac{1}{2}$ tablespoons, of the milk. With a few gentle strokes mix it slightly (not thoroughly) with the other ingredients.

   c) Repeat this addition of flour and milk alternately, using the same amounts and the same methods of combination as given above, except shorten the beating-period after the dampening of the flour to 10 seconds.

   End with a portion of the flour.

   The total time required for steps (*b*) and (*c*) is about 6 minutes.

   d) When all the flour has been added and the last portion dampened, beat the batter for 15 seconds if a tartrate, for 30 seconds if a calcium-phosphate, or for 1 minute if a S.A.S.-phosphate baking powder has been used. The batter will be very thick.

   e) Add the beaten whites and stir gently but quickly until the mixture can be beaten without spattering—about 5 seconds. Then beat for 25 seconds. Immediately turn the batter into the oiled tins.

7. Bake[1] as follows:
   a) For a tartrate or calcium-phosphate baking powder:
      (1) Layer cake—at 350° F. during the first 10 minutes, then at 375° F. for about 15 minutes longer.
      (2) Loaf cake—at 350° F. during the first 20 minutes, then at 375° F. for about 20 minutes longer.

   b) For a S.A.S.-phosphate baking powder:
      (1) Layer cake—at 300° F. during the first 10 minutes, then at 375° F. for about 20 minutes longer.

[1] Baking tests are given on page 71.

(2) Loaf cake—at 300° F. during the first 20 minutes, then at 375° F. for about 25 minutes longer.

8. As soon as the cake is taken from the oven, remove it from the pan and take the paper off the bottom. Place the cake on a rack to cool.

GINGERBREAD

Yield

As cup cakes: 11 cup cakes, 2½ inches in diameter and 1¼ inches high; as a loaf cake: 9 pieces, 2 inches by 2 inches by 1½ inches.

Baking pans

Capacity: 1,100 to 1,200 cubic centimeters (approximately 5 cups).

Pans used in this laboratory:

a) Eleven muffin-pan sections, each of 100 cubic centimeter capacity.

b) One loaf-cake pan 6½ inches by 6½ inches by 1½ inches.

Proportion of ingredients

	WEIGHT IN GRAMS	APPROXIMATE MEASURE
Pastry flour	144.0	1½ cups
Baking powder		
Tartrate	3.9	1 teaspoon
or		
Calcium-phosphate	4.0	1 teaspoon
or		
S.A.S.-phosphate	3.0	¾ teaspoon
Salt		¼ teaspoon
Ginger		1 teaspoon
Spice mixture[1]		4 teaspoons
or		
Cinnamon		2 teaspoons
and		
Cloves and allspice		1 teaspoon, each
Soda	3.3	1 teaspoon

[1] See footnote on page 81.

Proportion of ingredients—*Continued*

	WEIGHT IN GRAMS	APPROXIMATE MEASURE
Molasses (a light-colored cooking[1])	163.0	½ cup
Sugar	50.0	¼ cup
Fat (melted or a liquid fat)	53.2	¼ cup
Egg	48.0	1 medium sized
Boiling water	118.3	½ cup

Order of work

1. Assemble all ingredients and utensils needed. Oil the baking pans well—muffin pans are preferable.
2. (*a*) Weigh or measure the flour and baking powder. Measure the salt. Mix the three well; then sift them together.
   b) Measure the spices and soda. Place them in a small bowl and mix.
   c) Weigh or measure the molasses, sugar, and melted fat. Turn them into the mixing bowl and mix. Add the beaten egg and beat until it is well combined with the molasses, sugar, and fat (about 20 seconds).
3. Light the oven. Set it at 325° Fahrenheit.
4. Put some water on to boil.
5. Combine the remaining ingredients as follows:
   a) Add the mixture of flour, baking powder, and salt all at one time to the molasses-sugar-fat-egg mixture. Stir until the dry ingredients are just dampened (about ½ minute).
   b) Measure the boiling water; quickly mix it with the spices and soda and then turn this mixture into the mixture of molasses, sugar, fat, flour, and baking powder. Stir as vigorously as possible until the batter can be beaten without spattering (about 10 seconds). Then beat for 45 seconds if a tartrate, or for 1 minute if a calcium-phosphate or S.A.S.-phosphate powder has been used.

[1] The one which we happen to have used is the Dove brand.

The batter is very thin.

c) Immediately turn the batter into the pan.

6. Bake[1] as follows:
   a) Cup cakes—at 325° F. for about 25 minutes.
   b) Loaf cake—at 325° F. for about 30 minutes.

HERMITS

Yield

One and one-half dozen cookies about 2¼ inches in diameter.

Baking pans

Two baking sheets each with about 140 square inches of surface. The ones used in this laboratory are 10 inches by 14 inches.

Proportion of ingredients

	WEIGHT IN GRAMS	APPROXIMATE MEASURE
Raisins	80.0	½ cup
Pastry flour	128.0	1⅓ cups
Baking powder		
Tartrate	7.7	2 teaspoons
or		
Calcium-phosphate	8.0	2 teaspoons
or		
S.A.S.-phosphate	6.0	1½ teaspoons
Sugar	100.0	½ cup
Salt		¼ teaspoon
Spice mixture		2 teaspoons
or		
Cinnamon		1 teaspoon
and		
Cloves and allspice		½ teaspoon, each
Water (boiling)		2 teaspoons
Egg	48.0	1 medium sized
Milk	15.3	15 cubic centimeters (1 tablespoon)

[1] Baking tests are given on page 71.

Proportion of ingredients—*Continued*

	WEIGHT IN GRAMS	APPROXIMATE MEASURE
Butter (melted)..........	55.2	$\frac{1}{4}$ cup
or		
Other fat (melted or a liquid fat)...........	53.2	$\frac{1}{4}$ cup

Order of work

1. Assemble all ingredients and utensils needed in the preparation of the cookies. Oil the baking sheets.
2. Light an oven. Set it at 400° Fahrenheit.
3. (*a*) Cut the raisins into small pieces.
   b) Weigh or measure the flour, baking powder, and sugar. Measure the salt. Mix them well; then sift them into the mixing bowl.
   c) Put a small quantity of water on to boil. Measure the spices; and as soon as the water is hot, mix 2 teaspoons of it with the spices.
   d) Beat the egg until it is foamy; measure the milk and turn it into the egg.
   e) Weigh or measure the melted fat. Turn it slowly into the egg-milk mixture. Stir while it is being added.
4. Combine the wet and dry ingredients as follows:
   a) Just as soon as the fat has been poured into the egg and milk, pour this mixture and then the moist spices into the dry ingredients. Stir as vigorously as possible until the dry ingredients are dampened (about 30 seconds); add the raisins and continue stirring for about 30 seconds.
   b) Pick up in a teaspoon as much of the dough as the spoon will hold. Scrape it from the spoon on to the baking sheet, piling it up rather than spreading it out. Transfer the rest of the dough to the baking sheet in a similar manner. Leave at least 2 inches between cookies.
5. Bake at 400° F. until the cookies begin to brown; then lower the temperature to 350° F. The cookies are done when a toothpick stuck into the center comes out clean.

CHAPTER V

CAKES CONTAINING NO FAT

The chief difficulty in making angel-food and sponge cakes, the two types which contain no shortening, is to get the egg whites well mixed with the other ingredients without at the same time stirring out the air in the beaten whites. It is the expansion of air which makes the cake light; hence, if it is lost, the cake will be compact and heavy. On the other hand, if the egg whites are not well mixed with the other ingredients, the cake will be coarse and of uneven texture. The knack here consists, then, in being able to do much mixing with gentle movements. This point is well illustrated by the angel cakes pictured in Figures 19, 20, and 21. All of these cakes were made from the same proportion of weighed ingredients and all were put together in the same period of time, yet how different are the results! The cake of Figure 19 was made by a person who could fold gently but effectively—that is, she could really get the ingredients combined by gentle movements. This cake was excellent in every respect; it was very light, having about twice the volume of the batter from which it was made; it had a fine texture, and was very tender. The cake of Figure 20 was made by a student who used a choppy, up-and-down movement which did not really mix the ingredients but served only to stir out the air, with the result that her cake, as the picture shows, was very coarse in texture and of a small volume. The third cake in the series (Fig. 21) was made by a person with a "heavy hand" who went at the process with something of the vigor required for turning an ice-cream freezer. In this rough handling the air was lost, hence the cake was of small volume and quite compact and soggy.

In the section on manipulation we have described the folding process we use in combining the egg whites with the other ingredients in angel and sponge cakes. We realize, however, that what we have said can be interpreted in a number of ways, depending

on the reader's experience or lack of it in making cakes. It is, indeed, quite possible for the beginner's first cake to be a sad failure in spite of her best efforts. If it is, we hope that by matching it with one of our poor ones and rereading the directions she can tell what is wrong with it and what to do or leave undone in making the next one. Thus, if her cake looks like that in Figure 20, she has not done enough of the right kind of folding; whereas if it looks like that in Figure 21, she has committed a common error and folded so long, or more likely so roughly, as to remove most of the air.

INGREDIENTS

Cake flour and finely granulated sugar are especially desirable in angel food and sponge cakes, for both contribute much toward lightness and tenderness.

Cream of tartar appears to be an essential ingredient in angel cake and a desirable one in sponge cake. Without cream of tartar, angel cake is cream colored rather than white, and tends to shrink during the last few minutes of baking so that the volume after baking is but little greater than before.

MANIPULATION OF INGREDIENTS

In angel cakes we fold the other ingredients—sugar and flour—into the egg whites; whereas in sponge cakes we reverse the order and fold the whites into the other ingredients—egg yolks, sugar, and flour. The folding movement, however, is essentially the same for both cakes.

The folding movement.—Tip the bowl slightly toward the right hand and, with the bottom of the wire egg-whip held near and parallel to the side of the bowl, gently cut down through the egg whites. As the bottom of the bowl is approached, gradually shift the position of the egg-whip until it is brought along parallel to the bottom; then as the opposite side of the bowl is approached, again shift the position of the egg-whip so that as it is brought up it is parallel to that side. When the whip comes to the surface, turn it upside down so that it faces the bottom of the bowl. At the same time, carry it across to the other side of the bowl, holding it just above the surface of the mixture and moving it gently

FIG. 19.—Angel cake in which the ingredients were thoroughly combined by gentle movements. Note the fine, even grain and large volume.

FIG. 20.—Angel cake in which the ingredients were incompletely combined. Note the small volume and coarse grain as shown by the many large holes.

FIG. 21.—Angel cake in which the ingredients were roughly handled. Note the compact, soggy appearance and the small volume.

FIG. 22.—Biscuit made on first trial by an inexperienced person. The ingredients were well stirred together and the dough kneaded for a few seconds.

to avoid snapping off the mass of material clinging to it. This whole process constitutes one complete revolution of the whip and is the essential movement in folding. Each time it is made, the bowl should be rotated through an angle of about 45°, thus bringing a new portion of the mixture into contact with the whip at each of its revolutions.

For angel cakes, the folding process begins with the addition of the first portion of the sugar to the egg whites and is repeated after the addition of each successive portion of sugar or sugar and flour. Finally after the ingredients are seemingly combined, the folding movement is continued for a short time longer, as we work for about 2 minutes.

For sponge cake, folding begins with the addition of the beaten egg whites to the mixture of egg yolks, sugar, flour, and water and is continued until no flakes of egg white are visible, then for about 2 minutes longer.

If the folding is very *gently* done, there seems to be no particular danger of overmixing in any reasonable period of time; but rough handling, even for a short time, is disastrous, as can be seen by looking at the angel cake shown in Figure 21.

BAKING

Both angel and sponge cakes should be baked at a very low temperature if they are to be tender. This is because they contain a large proportion of eggs, which, as every one knows, are made tough by cooking at a high temperature.

They should not be removed from the pan until they are cooled and stiffened to the point where they will not collapse when handled.

DIRECTIONS FOR THE PREPARATION OF CAKES CONTAINING NO FAT

ANGEL-FOOD CAKE[1]

Yield

Twelve "pie-shaped" pieces, each 2 inches across the outer edge.

Utensils

A 3-quart, heavy mixing bowl, similar in shape to the one shown in Figure 7, facing page 42.

One baking pan: capacity, 3,000 cubic centimeters (approximately 12⅔ cups). The one used in this laboratory is 8½ inches in diameter by 3½ inches tall and has a tube extending through the center.

Proportion of ingredients

	WEIGHT IN GRAMS	APPROXIMATE MEASURE
Cake flour	96.0	1 cup
Fine granulated sugar	300.0	1½ cups
Egg whites (from fresh, cold eggs)	228.0	1 cup (whites from about 8 medium-sized eggs)
Salt		¼ teaspoon
Cream of tartar		1 teaspoon
Vanilla		½ teaspoon

Order of work: Detailed form

1. Assemble the ingredients and utensils necessary in the preparation of the cake. *Do not oil the baking pan.*
2. (*a*) Weigh or measure the flour.
   b) Weigh or measure the sugar, then mix about half of it

[1] Half of this recipe may be made according to the same directions. Convenient utensils are: a 1½-quart, heavy mixing bowl, similar in shape to that shown in Figure 7; a baking pan of 1,500 cubic centimeters (approximately 6⅓ cups) capacity (the one used in this laboratory is 6¾ inches in diameter by 3 inches high and has a tube extending through the center).

with the flour. This mixture is more easily folded with the whites than is flour alone.

c) Weigh or measure the egg whites, then place them in the mixing bowl.

d) Measure the salt and cream of tartar.

3. Light the oven; set it at 300° Fahrenheit.
4. Combine the ingredients as follows:

a) Sift the salt and cream of tartar over the surface of the egg whites; then with a double rotary egg-beater, beat the whites until they are stiff enough to hold their shape but *not until they lose their shiny appearance.*

b) Sift a thin layer of sugar over the entire surface of the whites (this will take about 2 tablespoons); then fold it into the whites. For a description of the folding process, see page 96.

c) Repeat this folding process for the rest of the sugar; and then for the sugar and flour mixture, sifting only about 2 tablespoons at one time over the egg whites.

d) After the addition of the last portion of the flour-sugar mixture, fold until it is combined with the egg whites.

e) Add the vanilla and continue folding gently for 2 minutes longer.

f) Pour the batter into the cake pan as soon as the folding has been completed. Lift the last portion lightly from the bowl into the pan, being careful not to stir it.

5. Bake at 300° F. for about $1\frac{1}{2}$ hours. The tests by which one may tell when the cake is done are the same as the tests for butter cakes, and are given on page 71.
6. After removing from the oven, immediately turn the cake pan upside down and let it remain so until the cake is cold. There should be an air space between the edge of the pan and the table. If the pan is not equipped with stands, it may be suspended between two pans.

Order of work: Abbreviated form

If the person who makes this cake decides to weigh the troublesome ingredients and to measure the others, a résumé of the directions is somewhat as follows:

1. Weigh or measure the ingredients:

Flour	96 grams	Add half the sugar to the flour; mix
Sugar	300 grams	
Egg whites	228 grams	Add salt and cream of tartar to the egg whites
Salt	$\frac{1}{4}$ teaspoon	
Cream of tartar	1 teaspoon	
Vanilla	$\frac{1}{2}$ teaspoon	

2. Light oven; set at 300° F.
3. Beat the egg whites with a double rotary egg-beater.
4. Fold into the egg whites, first the sugar then the sugar-flour mixture.
5. Add vanilla after the last portion of sugar-flour mixture has been folded in; then continue folding gently for 2 minutes.
6. Bake for about $1\frac{1}{2}$ hours.
7. Upon removal from the oven, invert tin and let it remain so until the cake is cool.

SPONGE CAKE

Yield

Twelve "pie-shaped" pieces, each 2 inches across the outer edge.

Utensils

A 3-quart, heavy mixing bowl, similar in shape to the one shown in Figure 7, facing page 42.

One baking pan: capacity, 3,000 cubic centimeters (approximately $12\frac{2}{3}$ cups). The one used in this laboratory is $8\frac{1}{2}$ inches in diameter by $3\frac{1}{2}$ inches tall and has a tube extending through the center.

Proportion of ingredients

	WEIGHT IN GRAMS	APPROXIMATE MEASURE	
Cake flour	96.0	1 cup	
Fine granulated sugar	200.0	1 cup	
Eggs			
Yolks	90.0	5 yolks	from medium-sized eggs
Whites	150.0	5 whites	

Proportion of ingredients—*Continued*

	WEIGHT IN GRAMS	APPROXIMATE MEASURE
Salt		$\frac{1}{4}$ teaspoon
Cream of tartar		$\frac{3}{4}$ teaspoon
Boiling water	44.4	3 tablespoons
Vanilla		$\frac{1}{2}$ teaspoon

Order of work: Detailed form

1. Assemble the ingredients and utensils needed in the preparation of the cake. *Do not oil the baking pan.*
2. (*a*) Weigh or measure the flour.
   b) Weigh or measure the sugar, then mix about half of it with the flour.
   c) Separate the whites from the yolks; place the yolks in the mixing bowl, and the whites in a bowl in which they can be beaten conveniently.
   d) Measure the salt and cream of tartar.
3. Light the oven; set it at 300° Fahrenheit.
4. Combine the egg yolks, sugar, and hot water as follows:
   a) Put some water on to boil.
   b) Beat the egg yolks with a double rotary egg beater until they are a very light-yellow in color and are so stiff that the beater is difficult to turn. This will take about 2 minutes.
   c) Add the sugar in four portions, approximately 2 tablespoons each. After each addition, beat with the egg-beater until the mixture thickens (about 10 seconds). When all the sugar has been added, the mixture should be so thick that it will hold its shape.
   d) Add the boiling water in three portions, a tablespoonful each, and beat about $\frac{1}{2}$ minute after each addition. Let this mixture stand until it is cool.
5. While this mixture cools, sift the salt and cream of tartar over the surface of the egg whites and beat the whites with a wire egg-whip (which is to be used later for folding in the whites) until they are stiff, but *not until they have lost their shiny appearance.*

6. Combine the rest of the ingredients as follows:
   a) Beat the egg-sugar-water mixture until it is so stiff that the beater turns with great difficulty. This will take about 1 minute if the mixture is cool when the beating is started; 2 or more minutes if it is not.
   b) Add about one-sixth (approximately 4 tablespoons) of the flour-sugar mixture. Stir with a wooden spoon until the dry ingredients are dampened; then beat for 10 seconds. Add the rest of the flour-sugar mixture in the same way.
   c) Add the beaten egg whites and vanilla. Using the wire whip, fold (with the motion described on page 96) until the whites have disappeared; then continue folding for 2 minutes.
   d) Immediately turn the batter into the pan.
7. Bake at 300° F. for about $1\frac{1}{2}$ hours, or until the crust is a golden brown and the cake springs back into place after being lightly touched with a finger tip.
8. Immediately after removing from the oven, turn the pan upside down (an air space should be left between the pan and the table top), and leave it so until the cake is cool.

FIG. 23.—Biscuit in which the ingredients were well stirred together and the dough kneaded for a few seconds. Made by an experienced person. Note the symmetrical shape and the freedom from spots.

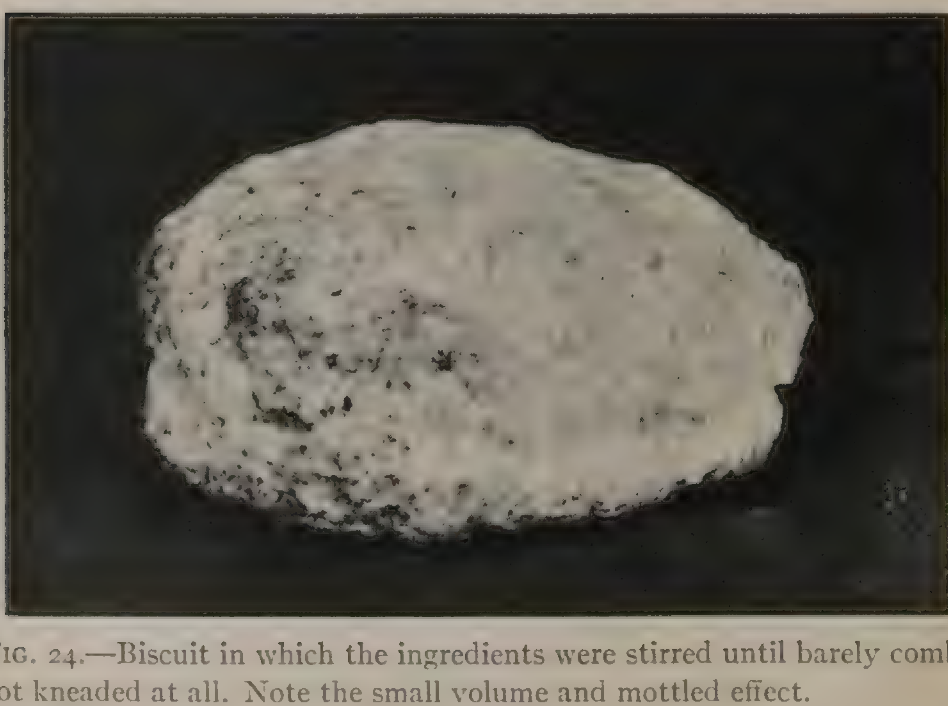


FIG. 24.—Biscuit in which the ingredients were stirred until barely combined, and not kneaded at all. Note the small volume and mottled effect.

CHAPTER VI

BAKING-POWDER BISCUITS

Good biscuits served piping hot, so hot that the butter melts the minute it touches them, are a great delicacy, as everybody will agree. They are, moreover, the quickest and easiest to make of all the batter and dough series, once one has acquired the so-called "knack" of making them. Without this knack, however, they give more trouble than anything else, with the possible exception of doughnuts. To be convinced of this, one has only to think of the awful products turned out by nearly all beginners and indeed by more than a few old hands at the job. Some of these biscuits are hard and leathery, others dry and crumbly, still others soft and doughy; but all are equally objectionable. Strange as it may seem, all these and also the best of biscuits can be made from one and the same ingredients in supposedly the same proportions. Failure or success depends upon the cook's method of measuring and combining the materials. Doing this in such a way as to produce good products constitutes the so-called "knack" of a good cook. How to do it for biscuits will be discussed presently. First, however, let us have clearly in mind what we mean by good biscuits—just what sort of product we are striving to obtain.

CHARACTERISTICS OF GOOD BISCUITS

Good biscuits are very light, the baked ones being about twice the volume of the unbaked. They are symmetrical in shape; that is, they rise evenly into almost perfect right cylinders with vertical sides and level tops, and they show no tendency to bulge out at one side or the other or to flatten out in shapeless form. Their tops are also fairly smooth and covered with a tender, golden-brown crust. These characteristics, especially that of regular shape, are well shown by the biscuit pictured in Figure 23.[1]

The inside of good biscuits is a creamy white, perfectly free

[1] Biscuit made by Gladys Vail.

from brown or yellow spots, and contains many small holes evenly distributed. It appears light and fluffy rather than compact and soggy. Moreover, it is flaky, that is, it has the characteristic of peeling off into long, thin sheets when a bit of it is grasped and pulled upward by the finger tips. This flakiness, which is always accompanied by extreme lightness, is one of the most desirable qualities of biscuits. These interior characteristics, unfortunately, do not show in a photograph, hence the foregoing description of them will have to suffice.

PROPORTION OF INGREDIENTS

The first difficulty encountered in making such biscuits as have just been described is to get just that proportion of liquid and flour which will give a soft, easily handled dough. Unfortunately, no one definite amount of liquid can be given to fit all circumstances, for the proportion varies with the absorptive power of the flour and with the thoroughness with which the liquid and flour are combined. It also varies with the kind of liquid, for obviously one can use a larger proportion of milk, which is but 87 per cent water, than of water itself. This explains why in our biscuit recipe (page 108) we tell what kind of liquid we use and why we limit the flour to the brands with which we have had experience (page 41). Whether these brands are sufficiently alike from year to year to warrant their general use in the proportion we have specified, we cannot say. At any rate we feel sure that, using these flours, the beginner can make such slight adjustment as may be required if she weighs—or, failing that, carefully measures—the flour, measures the milk in a graduated cylinder, and follows the method we give for combining the two. If the biscuits are too soft to handle, she can slightly decrease the milk; if they are too stiff, she can slightly increase it. After two or three trials she will strike the right proportion, a proportion which she can count on to hold good for at least the one sack of flour she has tested.

MANIPULATION OF INGREDIENTS

The difficulty in handling the ingredients comes in being able to do just that amount of stirring and kneading required to com-

bine thoroughly the liquid with the dry ingredients without overdoing the process and making the biscuits heavy by loss of carbon dioxide. It is probable, however, that few people err in overmixing; the usual thing is to undermix.

The method which we have found to be most effective is given in detail, with full explanations for each step of the process, in the pages that follow, and also in a more or less abbreviated form in the biscuit recipe, page 108. Though the whole procedure may seem somewhat complicated to the casual reader, we have found that it can be interpreted successfully by careful students. The biscuit shown in Figure 22 is typical of those made by a number of inexperienced persons in this laboratory, all of whom were provided with weighed materials and directions for working which they were allowed to interpret for themselves. In all cases fair biscuits were obtained at the first trial; and excellent ones, as good as those shown in Figure 23, at the second or third trial.

Directions for combining the liquid with the dry ingredients.—We begin by making a well in the center of the dry ingredients, after which we add all the liquid at once and then start stirring immediately. Until the flour is wetted, we have to be a little careful about our movements; but as soon as this is accomplished, we stir rapidly and vigorously until the mixture thickens to the point where it will follow the spoon around the bowl. As we work, the stirring takes about 20 seconds for the recipe calling for 2 cupfuls of flour, given on page 108. We begin to count the time the instant the wet ingredients are turned into the dry ones. If the recipe is doubled, the time of stirring must be increased—for our speed, to about 30 seconds. For the smaller recipe, we use a bowl with a capacity of 2 quarts; for the larger one, a 3-quart bowl.

Immediately after the mixture thickens, we turn it onto a lightly floured board (see below) and start to knead it. By the way it handles, we can tell whether or not we are going to have good biscuits. It should be extremely light and soft, but not sticky. A dough which sticks to everything it touches is bound to make poor biscuits, and the more we work with it the worse it becomes. On the other hand, a solid hard dough will make poor biscuits; and once made, nothing can be done to improve it. For the 2-cup

recipe, our best results are obtained by kneading continuously for about 20 seconds; about 30 seconds for one calling for 4 cups of flour.

What is meant by a "lightly floured board."—A lightly floured board is one covered by a very thin layer of flour, so thin that the board may be seen easily through it or a clean dry hand when laid upon it will pick up all the flour from the spot it touches. No more than 1 tablespoon of flour is necessary for flouring the board for both kneading and rolling the quantity of dough yielded by the recipe that follows.

Method of kneading.—Before beginning to knead, flour the hands lightly. In kneading, work mostly with the right hand, using the left one to hold the dough in shape and guide it over the board. With the finger tips of the right hand grasp the part of the dough that lies to the back of the board (that is, that portion lying farthest from the worker); bring it forward until it is practically even with the front edge of the dough. Let go of the dough and quickly press the ball of the hand upon the place where the fingers had been. Then while still pressing lightly downward, move the hand backward until the dough beneath the hand occupies the same position it did before kneading was begun. With the left hand turn the dough around a little and knead again. Continue the process of turning and kneading, working rapidly, keeping the dough in a ball and guiding it to another section of the floured board as soon as it begins to cling where it is.

Purpose of kneading.—The purpose of kneading is to effect a more thorough combination of the ingredients than can be accomplished by stirring only. With the proportions used in our biscuit recipe the mixture soon becomes too stiff to stir and if kneading is not resorted to, the ingredients are not sufficiently well combined to give biscuits of the finest texture. If more liquid is added so that more stirring can be done, the dough will not stiffen to the point where it can be handled. Besides, in such a soft dough much of the carbon dioxide will be lost during the stirring process and the finished product will be soggy rather than light.

Effects of overmixing and undermixing.—Although one occasionally sees biscuits made soggy by overmixing, we were not able to make such by a continuous process from the proportions of flour and liquid given unless we stirred and kneaded for a period exceeding $2\frac{1}{2}$ minutes. We assume, then, that overmixed biscuits are made by very slow workers, or by those who have been interrupted during the mixing process, or perhaps by those who have used too much liquid. In the latter event, one is almost certain to overstir in getting flour worked in to make it possible to handle the dough.

The usual trouble with biscuits is that they are undermixed. The effect of this is shown in the biscuit pictured in Figure 24. This one was made from the same ingredients in the same proportions as the biscuit of Figure 23. The only difference between the two was that in the one shown in Figure 24 no stirring was done in excess of that required barely to combine the ingredients, and no kneading at all, while that in Figure 23, as already stated, was made by stirring the dough until it thickened, and then kneading it for a few seconds. As may be noted, the one handled as little as possible was rough, solid, unattractive, and only about one-half the size of the kneaded one, although both were rolled to the same thickness and cut the same size. Furthermore, the texture was close and solid and had no appearance of flakiness, and the inside was yellow and contained many dark spots. These spots, according to a private communication from Dr. J. R. Chittick of the Jaques Manufacturing Company, are caused by the action of soda on the coloring-matter of the flour. This seems to be a reasonable explanation, since in the quick mixing to which these biscuits were subjected it might well be that not all of the soda had a chance to react with the acid components of the baking powder and therefore was free to act on the coloring-matter of the flour or some other component of the dough.

Method of rolling and cutting the dough.—After the dough is kneaded, it is patted or lightly rolled to about one-half the thickness desired in the baked biscuits. Care must be taken to avoid the use of any more flour in handling than is absolutely necessary.

If the dough has been properly made, this is a very small quantity indeed.

If the biscuits are to have a symmetrical shape, the cutter will have to be refloured after each cutting. This may be done without waste of time by dipping the cutter into a bowl of flour placed near by, and lightly tapping it against the edge of the bowl to dislodge the extra flour. After cutting, the biscuits should be picked up with a spatula and transferred carefully to the baking pan to avoid spoiling their shape.

After they have been transferred to the baking sheet, biscuits may stand without deterioration for at least 15 minutes, preferably in a refrigerator.[1] While standing, they should be covered with a clean, damp cloth to prevent the crust from drying.

BAKING

Biscuits should be baked in a very hot oven, that is, at a temperature around 425° Fahrenheit, for a lower temperature dries them out before they are baked.

DIRECTIONS FOR THE PREPARATION OF BAKING-POWDER BISCUITS AND STRAWBERRY SHORTCAKE

BAKING-POWDER BISCUITS

Yield

Twenty biscuits, each 2 inches in diameter and about $1\frac{1}{4}$ inches high.

Utensils

A 2-quart, heavy mixing bowl, similar in shape to the one shown in Figure 7, facing page 42.

One baking sheet with about 140 square inches of surface. The one used in this laboratory is 10 inches by 14 inches.

[1] Eleanor R. Maclay, "Effect of Delayed Baking upon Biscuits," *Journal of Home Economics*, XVIII (1926), 157.

Proportion of ingredients

	Weight in grams	Approximate measure
Flour		
Family	226.0	2 cups
or		
Pastry[1]	256.0	$2\frac{2}{3}$ cups
Salt		$\frac{1}{2}$ teaspoon
Baking powder		
Tartrate	15.4	4 teaspoons
or		
Calcium-phosphate	16.0	4 teaspoons
or		
S.A.S.-phosphate	12.0	3 teaspoons
Fat (cold)	67.7	$\frac{1}{3}$ cup
Milk	174.0	168 cubic centimeters ($\frac{2}{3}$ cup plus 2 teaspoons)

Order of work: Detailed form

1. Assemble the utensils and ingredients needed in the preparation of the biscuits. The baking sheet need *not* be oiled. Flour the board and rolling pin lightly (see page 106).
2. (*a*) Weigh or measure the flour and baking powder. Measure the salt. Mix the three; then sift them into the mixing bowl.
   b) Weigh or measure the fat; then turn it into the mixture of flour, baking powder, and salt.
   c) Weigh or measure the milk.
3. Light the oven; turn it to 425° Fahrenheit.
4. Combine the ingredients as follows:
   a) Combine the sifted dry ingredients and the fat by rubbing them together between the fingers and thumb. To do this, pick up a portion of fat and flour, rub it lightly, then drop it and pick up another portion, rub and drop back into the bowl as before. Continue this process

[1] Cake flour may be substituted, weight for weight, for pastry.

until the mixture is fairly smooth and has the general consistency of coarse cornmeal.

b) Turn the milk all at once into the fat-flour mixture and stir vigorously until it thickens (for about 20 seconds).

c) Turn the dough onto the lightly floured board and without delay knead it vigorously for about 20 seconds. The process of kneading consists in grasping lightly with floured finger tips the part of the dough that lies to the back of the board, bringing it forward, then pushing it backward with the ball of the hand; then repeating the process. If the dough begins to stick during kneading, another thin layer of flour may be dusted over the board.

5. Roll and prepare for baking as follows:

   a) Shape the dough into a ball; then pat it with the hand, or roll with a rolling pin, to the desired thickness. A good thickness is from $\frac{1}{2}$ to $\frac{3}{4}$ inches. To use a rolling-pin, touch the center of the ball of dough very lightly with the floured pin, roll very lightly to an edge; repeat, rolling in a different direction each time in order to keep the edge round.

   b) Cut the dough with a floured biscuit-cutter. To flour the cutter, dip it into a bowl of flour, removing the excess by tapping the cutter gently on the board.

   c) If biscuits with crusty sides are desired, place them a half-inch or more apart on the baking sheet. In order to keep the shape symmetrical, use a spatula with a wide blade in transferring the biscuits from the board to the baking sheet.

6. Bake at 425° F. for about 12 minutes, or until the crust is an even brown, and the inside is light, flaky, and dry.

Order of work: Abbreviated form

If the person who is to make the biscuits chooses to use a tartrate baking powder, to weigh the fat and flour, and to measure the milk in a graduated cylinder, a résumé of the recipe is somewhat as follows:

1. Weigh or measure the ingredients:

Family flour	226.0 grams
Salt	$\frac{1}{2}$ teaspoon
Baking powder	4 teaspoons
Fat (cold)	67.7 grams
Milk	168 cubic centimeters

2. Sift salt and baking powder with the flour; work the fat into the dry ingredients.
3. Add the milk, all at one time, to the fat-flour mixture; stir vigorously until the mixture thickens (about 20 seconds).
4. Knead about 20 seconds.
5. Roll to about $\frac{1}{2}$ to $\frac{3}{4}$ inch thickness.
6. Cut, transfer to baking sheet, and bake at 425° F. for about 12 minutes.

STRAWBERRY SHORTCAKE

Yield

Four individual shortcakes each $2\frac{3}{4}$ inches in diameter.

Utensils

A 2-quart, heavy mixing bowl, similar in shape to the one shown in Figure 7, facing page 42.

One baking sheet with about 70 square inches of surface.

A biscuit-cutter about $2\frac{3}{4}$ inches in diameter.

Proportion of ingredients

a) For the filling

	WEIGHT IN GRAMS	APPROXIMATE MEASURE
Strawberries		$\frac{3}{4}$ quart
Sugar	50 to 100	$\frac{1}{4}$ to $\frac{1}{2}$ cup

b) For the crust

Flour		
Family	84.8	$\frac{3}{4}$ cup
or		
Pastry	96.0	1 cup

Proportion of ingredients—*Continued*

	WEIGHT IN GRAMS	APPROXIMATE MEASURE
Salt		$\frac{1}{4}$ teaspoon
Sugar		1 teaspoon
Baking powder		
Tartrate	5.8	$1\frac{1}{2}$ teaspoons
or		
Calcium-phosphate	6.0	$1\frac{1}{2}$ teaspoons
or		
S.A.S.-phosphate	4.0	1 teaspoon
Fat		
Solid fat	25.4	2 tablespoons
and		
Butter	6.6	$\frac{1}{2}$ tablespoon
Milk	61.0	59 cubic centimeters ($\frac{1}{4}$ cup)

Order of work

1. Prepare the filling as follows:

   Wash and stem the strawberries. Set aside about a cupful of the nicest ones. Cut the rest into halves or quarters, add the sugar; crush; and allow to stand until the crust is baked.

2. Prepare the crust[1] as follows:

   a) Sift salt, sugar, and baking powder with the flour; work the fat into the dry ingredients.
   b) Add the milk, all at one time, to the fat-flour mixture; stir vigorously until the mixture thickens (about 20 seconds).
   c) Knead about 20 seconds.
   d) Roll to about $\frac{1}{4}$ inch in thickness.
   e) Cut into eight discs with a biscuit-cutter. Spread a thin layer of melted butter over half the discs, and place over

[1] The directions for preparing shortcake crust are exactly the same as those for preparing biscuit. An abbreviated form of these directions is given here.

each of these an unbuttered disc to make a two-layer crust.

f) Bake for 18 to 20 minutes in an oven at 425° Fahrenheit.

3. Prepare the shortcakes for serving as follows:

Just as soon as the crusts are baked, remove them from the oven, separate the two layers, and butter the inner sides. Put each lower crust on a dessert plate and cover it with a layer of crushed strawberries. Place the upper crust, buttered side up, over the lower one, cover it with a layer of the crushed strawberries and then garnish with a few of the whole strawberries reserved for this purpose. Serve at once.

CHAPTER VII

PIES

PLAIN PASTRY (PIE CRUST)

CHARACTERISTICS OF GOOD PIE CRUST

In appearance, good pie crust is flaky, that is, its surface has a rough, almost blistered appearance rather than a smooth firm one. Moreover, it is tender enough to cut easily with a fork, but not so tender that it crumbles. It is a golden-brown color around the edge, a somewhat lighter brown on the bottom; and, even though containing a filling, it is crisp on the bottom as well as along the edges.

MANIPULATION OF INGREDIENTS

Combination of fat and flour.—The "secret" of making good, flaky pastry appears to be largely a matter of not overmixing the ingredients. If once the fat, flour, and liquid are all divided into tiny particles and these intimately mixed one with the other, they tend to stay that way and give a smooth, solid, tough crust which is impervious to heat and browns unevenly, if at all.

Care in mixing the ingredients should begin with adding the fat to the flour. With the large proportion of fat used, it is easy enough for the inexperienced person, more especially one who uses her fingers, to keep on working the ever warming fat into the flour until the grains of the latter become so coated with grease that they will not take up enough water to make the pastry flaky. What we really want are particles of *fat coated with flour*, and that is what we have if we do not overdo the combining process. There is little danger of doing this, however, if one starts with cold fat, works quickly, and uses knives rather than the fingers in mixing the fat with the flour. The reader may be interested to know that we ourselves never cut fat in with knives. Instead, we use our fingers exactly as for biscuits. We work quickly, however, using no more than a minute to combine the fat and flour for one pie.

Addition of water.—The most important point, however, is to add the water in such a way as to distribute it evenly among all the little fat-flour particles. They are all greedy for water and will absorb enough to make them sticky if they get the chance. If this happens, we shall have to stir the mixture vigorously, perhaps even work in more flour in order to get a dough which can be handled, with the result that we make it tough and rubbery.

What we try to do is to give each fat-flour particle just enough water to dampen it to the point where it will stick to its neighbor. We do this by sprinkling a small portion of the water over the surface of the fat-flour mixture, then stirring the two together with a fork, using a tossing motion made by running the fork along the bottom of the bowl and bringing it up gently through the mixture. Such a motion exerts no appreciable pressure but serves to make such particles as are dampened stick together and roll up into little lumps. Each time we add water we try to put it on an undampened spot. At first we sprinkle it between lumps; at last we move the lumps to one side and sprinkle the unwetted portion thus exposed to view.

To determine when we have added enough water, we press the dampened particles gently to see if they tend to stick together. If they do not, we add a bit more water. If they do, we divide them into the required number of portions, each of which we form into a disc by pressing the particles firmly together without the least bit of mixing or kneading.

If the process has been successfully carried out thus far, we shall now have a ball of dough which is easy to handle, being neither sticky because of too much water nor crumbly because of too little, and one which will yield tender, flaky pastry. If not, there is nothing to do but hope for better luck next time. Remodeling a dough at this stage simply does not work. The extra stirring and mixing required to add more flour or liquid, as the case may be, is almost certain to give a tough, rubbery crust in place of the tender, flaky one we are trying to make.

The ticklish business of adding the water would be somewhat simpler if we could give an exact measure of water which could be counted on to give just the right degree of dampness for a

given weight of fat and flour. This, however, we cannot do, for the amount varies with the temperature and the fineness of division of the ingredients and the rate of adding it. It is less for warm than for cold ingredients, less for finely divided particles than for coarse ones, and more when the water is added slowly rather than quickly.

We have the best results when the water added lies within the limits suggested in the pastry recipe (page 120). Much less tends to give a crust which is crumbly rather than flaky, while any appreciable increase makes for toughness. We can stay within these limits easily enough if we keep the ingredients cool and take 4 to 5 minutes to add the water, beginning to count the time when we sprinkle on the first portion of water and ending when the dough is shaped ready for rolling.

If the room is cool and we work quickly, we take no special precaution regarding the temperature of the ingredients other than to keep the fat in the refrigerator until we are ready to use it, and to have the water cold enough for drinking. If, however, the room is hot and damp, we set the fat-flour mixture in the refrigerator to chill before adding the water, and, if necessary, chill the dough before rolling it. In other words, we keep the mixture so cool that the fat shows no tendency to melt.

Rolling and placing the crust.—If we have succeeded in making a dough which is neither sticky nor crumbly and we have it in the form of a disc whose outer edges are so firmly pressed together that they do not fray, it is easy enough to roll a crust into a circular sheet of uniform thickness with the use of very little flour. Directions for doing this are given in the pastry recipe on page 120.

a) Lower crust: For a deep pie tin such as we use, perpendicular height $1\frac{1}{4}$ inches, we find that the diameter of the bottom crust should be about $2\frac{1}{2}$ inches greater than that of the outside diameter of the top of the pan in order to allow enough dough to fit down into the pan without leaving large air spaces between the two. Such air would, of course, expand during baking, pull the crust back from the edge of the pan, and give the pie a shrunken appearance. Furthermore, a crust which does not fit the pan is liable to break under the weight of the filling, with the result

Courtesy of the Evaporated Milk Association

FIG. 25.—Pie shell ready to be baked. The crust is held in place during baking by a second pie pan.

FIG. 26.—By holding the pie and the knife in this position, the surplus crust can be trimmed off without cutting away so much of it that the tin is exposed to view when the pie is baked.

that the filling runs under the crust. If much liquid is present, as in custard pie, the crust may absorb water and swell till the whole pie seems to be one mass of water-logged dough.

Pie shells, that is, lower crusts baked before the filling is added, have a great tendency to bulge up from the tin even if they seemingly fit it like the paper on the wall. The usual method of overcoming this tendency is to make a number of small holes along the bottom and sides of the crust with a fork before putting it in to bake, and to prick any bubble which chances to form during baking before the dough sets. Perhaps a better way is to hold the crust down to the tin by placing inside it another tin of the same size which is allowed to stay there throughout the baking period (Fig. 25).

b) Upper crust: The upper crust need be but slightly larger than the pie it is to cover, just enough to allow for the rounding up of the filling. Before putting it in place, a few holes should be made to allow for the escape of steam from the filling during cooking. These holes are usually arranged in a design to add to the attractiveness of the pie. In making this design, one should avoid cutting long slashes through the crust, for these tend to tear in transferring the pastry from the board to the pan and to spread during baking, thereby ruining the appearance of the pie.

In order to make the upper and lower crusts stick together and thus prevent juice from running out at the edges, it is customary to dampen the outer edge of the lower crust just before putting the upper one in place and to cement the two together by pressing firmly all around the edge with the tines of a fork, held points in, or with the fingers. Not until this is done should the surplus crust be trimmed off. To do this without cutting off more crust than is absolutely necessary for an even edge, one should hold the pie on the palm of the hand and the knife underneath with its cutting-edge just touching the tin and making an angle of about forty-five degrees with it on the under side (Fig. 26).

BAKING

Pie shells should be baked in a very hot oven (450° F.) until they feel firm and dry and until the edge of the crust is an even golden-brown.

The temperature at which filled pies are baked depends on the filling, and will be given under the individual pie recipes. In general, however, such pies are placed in a hot oven for the first few minutes in order to start the baking of the lower crust before the filling has had time to soak into it; then during the rest of the period they are baked at a lower temperature suited to the filling. Both crusts should be an even golden-brown when the baking-period is over.

PIE FILLINGS

Pie fillings, strangely enough, give the beginner far less trouble than the crust itself. For this reason the discussion on fillings is limited to a few words, whereas much space has been devoted to the hows and why of preparing the crust.

CUSTARD PIE

A good custard pie filling resembles a good fruit jelly in that it is tender and quivery, yet keeps its angles when cut and does not "weep" on standing. Furthermore, it has a delicate golden-brown surface entirely free from the heavy, dark-brown layer sometimes observed on this type of pie.

The chief difficulty encountered in making custard pie is in the baking. If the temperature of the oven is high, the filling will be tough and have a tendency to weep; whereas if it is low, the filling will soak into the crust unless the latter has been baked by itself before the filling is added. Since, then, it is extremely difficult to find temperatures suitable for baking both filling and crust at the same time, it is highly desirable to bake the crust separately. When this is done, the temperature of the oven can be regulated to that required by the filling without danger of a soaked crust.

PUMPKIN PIE

Pumpkin pie filling resembles custard in its general characteristics. It has more body, however, and therefore lacks the delicate jelly-like consistency of the latter.

The chief requirement in the preparation of pumpkin filling is pumpkin cooked sufficiently dry that liquid has no tendency to seep from it as it stands. Canned pumpkin often fulfils this con-

dition, and is more convenient to use than fresh. The latter requires a long preliminary preparation. It must be pared and steamed or boiled in the same manner as squash (see page 24), drained, mashed, reheated over a *very low* flame with constant stirring until no more water separates from it, and finally cooled somewhat, before it is ready to use in the filling.

With good pumpkin to draw from, this pie is more easily prepared than custard because both crust and filling can be baked together without harm to either. This is partly because this filling, unlike custard, can stand the high initial temperature required for cooking the crust; and partly because the pumpkin mixture, being somewhat thicker than the custard, has less tendency to soak into the crust.

CREAM PIES

The filling for cream pies, including chocolate, lemon, cocoanut, and those containing such fruit as pineapple and bananas, should be so stiff that it will not run over the plate when cut, but not so stiff as to be pasty, as indicated by its tendency to hold its cut edges rigidly. Such filling, moreover, should be perfectly smooth, with all the ingredients so well blended together that there is not the faintest suspicion of lumpiness. Finally, there should be no flavor of raw starch in the cooked filling.

In order to obtain such a filling, one must be careful to use just the proportion of flour or starch called for in the directions; to cook the mixture carefully, preferably in a double boiler; and during cooking to stir it constantly until it thickens.

DIRECTIONS FOR THE PREPARATION OF PLAIN PASTRY (PIE CRUST)

Before attempting to use this recipe, read the preceding discussion on pies and the section on weighing and measuring (page 26).

Yield

One crust for a pie pan $8\frac{1}{4}$ inches in diameter (at the top) and $1\frac{1}{4}$ inches deep. This crust is enough for a one-crust pie which cuts into 6 pieces, each about $3\frac{3}{4}$ inches across the outer edge.

Proportion of ingredients

	WEIGHT IN GRAMS	APPROXIMATE MEASURE
Flour		
Pastry[1]	96.0	1 cup
or		
Family	84.8	$\frac{3}{4}$ cup
Salt		$\frac{1}{2}$ teaspoon
Solid fat (cold)	38.1	3 tablespoons
Water (cold)	28 to 33	28 to 33 cubic centimeters (2 tablespoons)

Order of work

1. Assemble the ingredients and utensils needed in the preparation of the pastry. Dust a very thin layer of flour over the rolling-pin and board. No more than a tablespoon of flour should be used on the pin and board during the entire rolling process.
2. Note that the proportions are given for *one* crust. If *two* crusts are desired, take twice the amount specified for each ingredient.
3. (*a*) Weigh or measure the flour. Measure the salt. Turn them into the mixing bowl.
   b) Weigh or measure the fat and put it into the flour.
   c) Weigh or measure the water.
4. Combine the ingredients as follows:
   a) Mix the fat with the flour and salt either by cutting the two together with knives or by rubbing them together with the fingers.

   To use knives, hold one in each hand and cut back and forth through the mixture until it is separated into particles none of which are larger than a navy bean.

   To use the fingers, pick up a portion of fat and flour, rub it lightly, then drop it and pick up another portion, rub and drop back into the bowl as before. Continue this process until none of the flour-fat particles are larger than a navy bean.

[1] Cake flour may be substituted, weight for weight, for pastry.

b) Add the water to the flour-fat mixture slowly—about $\frac{1}{2}$ teaspoon at a time—always sprinkling it over a considerable area of dry material. Hold a fork ready; and just as the water is added, bring the damp portion in contact with dry material by two or three gentle strokes. Distribute the water evenly in this way until the whole mixture is uniformly dampened.

5. If one crust is being prepared, press all of the flour-fat particles firmly together either with the hands or with the back of a spoon.

   If two crusts are being prepared, divide the mixture into two equal portions and press the particles of each firmly together.

   Do not handle the dough any more than is necessary.

6. Shape and roll the dough as follows:

   a) Lay a ball of dough on the floured board; pat it until it becomes flat on top. If the edge begins to split, pinch the cracks together.

   b) Place the rolling-pin lightly on the center of the dough and roll toward the edge with successive short strokes in such directions as will keep the shape round. As soon as the dough begins to stick to the board (which is indicated by its failure to spread out as the rolling-pin passes over it), loosen it gently along one edge with the side (*not the point*) of a spatula. Then turn the freed portion over the palm of the left hand and rest it there while the remainder of the crust is loosened and the board redusted with flour.

   Continue the rolling process until the crust is about $\frac{1}{16}$ inch thick.

7. Place the lower crust in the pan as follows:

   a) When the dough has been rolled to the desired thickness, loosen it from the board and transfer it to the pie tin. As an aid in transference, the crust, after loosening, may be lightly folded together by bringing one half over the other (forming a semicircle), then folding again lengthwise (forming a quarter-circle).

b) Place the pastry in a pie tin[1] (which need not be oiled) so that it covers the surface smoothly and loosely. Fit it carefully into the angle between the side and bottom of the tin, pressing it down into the crease with the fingers of one hand while the other hand holds the sheet away from the sides of the tin so that it will not be stretched or broken.

8. The treatment of the crust from now on depends upon the type of pie for which it is to be used. Therefore the directions for each type are given separately.

a) For a one-crust pie in which the crust is to be baked alone:

(1) Trim off the pastry so that the edge of the sheet comes all the way out to the edge of the flange and leave the rim plain, or press it with the tines of a fork; *or*, trim off the pastry about $\frac{1}{4}$ inch larger than the pan, roll the extra dough onto the rim of the pie pan, and pinch portions of it together with the finger and thumb into a fluting that stands above the edge of the pan (see Fig. 25).

(2) With a paring knife (or fork) make a number of small holes in the bottom and along the sides of the crust; *or*, place over the crust a pie tin of the same size as the one holding the crust (see Fig. 25). (In the latter case, do not pierce the pastry.)

(3) Place in an oven at 450° F. During the first 4 or 5 minutes of baking, watch the crust carefully if it is not covered by another pan. While still soft, prick more holes wherever it bulges away from the pan.

(4) Pie shells should be baked about 12 minutes, or until they are a golden brown around the edge and slightly brown on the bottom.

b) For a one-crust pie in which the crust and filling are to be baked together:

(1) Trim off the pastry so that its edge fits the pan,

[1] For a one-crust pie in which the shell is to be baked alone, the pastry may be fitted, if desired, over the outside of the inverted pie tin rather than over the inside.

leaving the rim plain or pressing it with the tines of a fork; *or*, trim off the pastry about $\frac{1}{4}$ inch larger than the pan, roll the extra dough onto the rim of the pan, and pinch portions of it together with the finger and thumb into a fluting that stands above the edge of the pan (see Fig. 25).

(2) Add part of the filling. Place the pie on the oven rack, being careful to have the rack level. Add the rest of the filling. Bake at a temperature suitable for the filling. (See individual pie recipe for the temperature.)

c) For a two-crust pie:

(1) Roll the second portion of the dough in the same manner as the first into a sheet $\frac{1}{16}$ inch thick; loosen it from the board; and cut small holes in the center. These holes are usually arranged in a design.

(2) Put the filling into the lower crust.

(3) Dampen the lower crust around the edge.

(4) Lay the upper crust lightly over the filling.

(5) With the tines of a fork, press the edges of the two crusts firmly together; then trim off the edges (see Fig. 26).

(6) Bake at a temperature suitable for the filling. (See individual pie recipe for the temperature.)

DIRECTIONS FOR THE PREPARATION OF PIES[1]

Yield for each recipe

One pie which will cut into 6 sectors, each $3\frac{3}{4}$ inches across the outer edge and $1\frac{1}{4}$ inches deep.

Baking pan for each recipe

Capacity: 685 cubic centimeters (approximately $2\frac{7}{8}$ cups).

Pan used in this laboratory: $8\frac{1}{4}$ inches in diameter (at the top) and $1\frac{1}{4}$ inches deep.

[1] For the convenience of the person who uses these directions, we have repeated with each recipe the proportions and an abbreviated form of the method of preparing pie crust. Detailed directions for its preparation are given on pages 119–23.

Careful measurement of the ingredients used in *pie fillings* will give proportions sufficiently accurate for home cooking.

CUSTARD PIE

Proportion of ingredients

a) For the filling

	WEIGHT IN GRAMS	APPROXIMATE MEASURE
Eggs	96.0	2 medium sized
Sugar	100.0	½ cup
Coffee cream (18 per cent)	159.4	⅔ cup
Milk	325.3	1⅓ cups (315 cubic centimeters)
Nutmeg		½ teaspoon

b) For the crust

	WEIGHT IN GRAMS	APPROXIMATE MEASURE
Flour		
Pastry	96.0	1 cup
or		
Family	84.8	¾ cup
Salt		½ teaspoon
Solid fat (cold)	38.1	3 tablespoons
Water (cold)	28 to 33	28 to 33 cubic centimeters (2 tablespoons)

Order of work

1. Prepare the pie shell as follows:
   a) Mix the salt with the flour; cut the fat into this mixture; then add the water *slowly* until all the dry material is damp.
   b) Press this dampened material firmly together; roll into a sheet about $\frac{1}{16}$ inch in thickness; fit into a pie pan; cover with another pie pan; bake until brown in an oven at 450° Fahrenheit. As soon as the crust is baked, lower the oven regulator to 300° F.
2. While the crust is baking, prepare the filling as follows:
   a) Weigh or measure the milk. Heat it in a double boiler while the rest of the filling is being prepared.
   b) Beat the eggs in a bowl large enough to hold all the

filling until the whites and yolks are well mixed but are only slightly foamy.

c) Weigh or measure the sugar. Add it to the eggs and beat the two with a spoon until they are mixed.

d) Weigh or measure the cream. Turn it into the egg-sugar mixture.

e) Stir the hot milk slowly into the egg-sugar-cream mixture.

3. Immediately pour about three-fourths of the filling into the hot pie crust; then set the pie on the oven rack. Add the rest of the filling. Sprinkle the nutmeg over its surface.
4. Bake at 300° F. until a silver knife, run into the center of the filling, comes out clean (about 30 minutes).
5. Remove the pie from the oven just as soon as the custard is baked. Place it on a rack to cool.

Serve it the same day it is made, but do not cut it until it is cool.

PUMPKIN PIE

Proportion of ingredients

a) For the filling

	WEIGHT IN GRAMS	APPROXIMATE MEASURE
Cooked pumpkin	310.0	$1\frac{1}{4}$ cups
Light-brown sugar	175.0	$\frac{7}{8}$ to 1 cup
Salt		$\frac{1}{2}$ teaspoon
Eggs	96.0	2 medium sized
Hot water		$\frac{1}{4}$ cup
Ginger and cinnamon		1 teaspoon, each
Orange juice		$2\frac{1}{2}$ tablespoons
Milk	244.0	1 cup (237 cubic centimeters)

b) For the crust

Flour		
Pastry	96.0	1 cup
or		
Family	84.8	$\frac{3}{4}$ cup

Proportion of ingredients—*Continued*

	WEIGHT IN GRAMS	APPROXIMATE MEASURE
Salt	....	$\frac{1}{2}$ teaspoon
Solid fat (cold)	38.1	3 tablespoons
Water (cold)	28 to 33	28 to 33 cubic centimeters (2 tablespoons)

Order of work

1. Prepare the filling as follows:
   a) Weigh or measure the pumpkin. Place it in a bowl large enough to hold all of the pie filling.
   The pumpkin must be smooth and not watery.
   b) If the sugar contains any lumps, roll it before weighing or measuring; measure the salt; turn it into the sugar; then mix the two with the pumpkin.
   c) Beat the eggs until the yolks and whites are well mixed together. Stir them into the pumpkin-sugar mixture.
   d) Measure the spices and hot water; stir them together. Weigh or measure the milk. Measure the orange juice. Mix the spices, milk, and orange juice with the pumpkin-sugar-egg mixture.
2. Prepare the pie shell as follows:
   a) Mix the salt with the flour; cut the fat into this mixture; then add the water *slowly* until all the dry material is damp.
   b) Press this dampened material firmly together; roll into a sheet about $\frac{1}{16}$ inch in thickness; fit into a pie pan.
3. Pour about three-fourths of the filling into the unbaked shell; set the pie on the oven rack; add the rest of the filling.
4. Bake the pie at 425° F. for the first 20 minutes; then lower the regulator to 250° F. and continue the baking for 40 minutes longer. When the pie is completely baked, the filling will be firm and will not stick to a knife blade. The edge of the crust will be a golden brown.
5. As soon as the pie is removed from the oven, set it on a rack to cool. Serve it on the same day that it is prepared.

CHOCOLATE PIE

Proportion of ingredients

a) For the crust

	WEIGHT IN GRAMS	APPROXIMATE MEASURE
Flour		
Pastry	96.0	1 cup
or		
Family	84.8	$\frac{3}{4}$ cup
Salt		$\frac{1}{2}$ teaspoon
Solid fat (cold)	38.1	3 tablespoons
Water (cold)	28 to 33	28 to 33 cubic centimeters (2 tablespoons)

b) For the filling

Bitter chocolate	28.3	1 square
Milk	325.0	$1\frac{1}{3}$ cups (315 cubic centimeters)
Sugar	133.5	$\frac{2}{3}$ cup
Flour		
Pastry	24.0	4 tablespoons
or		
Family	24.0	$3\frac{1}{2}$ tablespoons
Salt		$\frac{1}{8}$ teaspoon
Egg yolks	36.0	2 medium sized
Butter	8.8	2 teaspoons
Vanilla		$\frac{1}{2}$ teaspoon

Order of work

1. Prepare the pie shell as follows:
   a) Mix the salt with the flour; cut the fat into this mixture; then add the water *slowly* until all the dry material is damp.
   b) Press this dampened material firmly together; roll into a sheet about $\frac{1}{16}$ inch in thickness; fit into a pie pan; prick or cover with another pie pan; bake until brown in an

oven at 450° Fahrenheit. As soon as the crust is baked, lower the oven regulator to 300° F.

2. Prepare the filling as follows:
   a) Weigh or measure the chocolate. Melt it in a double boiler.
   b) Weigh or measure the sugar. Add it to the melted chocolate, and mix the two together.
   c) Weigh or measure the flour. Measure the salt. Mix them thoroughly with the chocolate-sugar mixture.
   d) Weigh or measure the milk. Heat it, but do not let it come to the boiling-point. Stir it frequently to prevent scorching. As soon as it is hot, stir it into the chocolate-sugar-flour mixture gradually in order to prevent lumping. Be sure the dry ingredients that cling around the edge of the pan are mixed with the rest.

      Cook this mixture in the double boiler for about 15 minutes. Stir it constantly until it thickens. Then cover the double boiler. At the end of this cooking-period, the filling should be sufficiently thick that a spoonful, when removed and turned back, falls in ridges which do not disappear for about a minute.
   e) Separate the egg whites from the yolks. Place the whites in a bowl in which they can be beaten conveniently, for they are to be used later in the preparation of meringue. Beat the yolks slightly.
   f) Stir about a fourth of the hot mixture into the egg yolks, at first slowly. Return this mixture to the double boiler. Then cook the filling about 2 minutes longer. During this cooking, the mixture will thicken a little, but it should remain thin enough to pour from the pan.
   g) Remove from the fire; add the butter and vanilla; beat until smooth; then pour into the pie crust.
3. Prepare meringue according to the directions given below; spread it over the filling, and brown it in the oven at 300° F.
4. Do not cut the pie until it is cold. Serve it on the same day that it is prepared.

MERINGUE

Proportion of ingredients

	WEIGHT IN GRAMS	APPROXIMATE MEASURE
Egg whites (left from a filling)	60.0	2 medium sized
Granulated sugar	25.0	2 tablespoons

Order of work

1. Beat the egg whites until they are foamy and white in appearance and are almost, but not quite, stiff enough to hold their shape.
2. Weigh or measure the sugar. Sprinkle it over the surface of the whites. Then continue beating with the egg-beater until the mixture is stiff enough to hold its shape.
3. Immediately spread it over the pie filling, being careful to make it touch the crust around the edge of the pie.
4. Brown the meringue in an oven at 300° F. This will take about 15 minutes.

LEMON CREAM PIE

Proportion of ingredients

a) For the crust

	WEIGHT IN GRAMS	APPROXIMATE MEASURE
Flour		
Pastry	96.0	1 cup
or		
Family	84.8	$\frac{3}{4}$ cup
Salt		$\frac{1}{2}$ teaspoon
Solid fat (cold)	38.1	3 tablespoons
Water (cold)	28 to 33	28 to 33 cubic centimeters (2 tablespoons)

b) For the filling

Flour		
Pastry	24.0	$\frac{1}{4}$ cup
or		
Family	24.0	$3\frac{1}{2}$ tablespoons

Proportion of ingredients—***Continued***

	WEIGHT IN GRAMS	APPROXIMATE MEASURE
Sugar	150.0	$\frac{3}{4}$ cup
Eggs		
Whole	48.0	1 medium sized
Yolks	54.0	3 medium sized
White	30.0	1 medium sized
Lemon rind		1 teaspoon (rind of 1 lemon)
Lemon juice		$\frac{1}{3}$ cup[1] (79 cubic centimeters)
Milk	325.3	$1\frac{1}{3}$ cups (315 cubic centimeters)

Order of work

1. Prepare the pie shell as follows:
   a) Mix the salt with the flour; cut the fat into this mixture; then add the water *slowly* until all the dry material is damp.
   b) Press this dampened material firmly together; roll into a sheet about $\frac{1}{16}$ inch in thickness; fit into a pie pan; prick or cover with another pie pan; bake until brown in an oven at 450° Fahrenheit. As soon as the crust is baked, lower the oven regulator to 300° F.
2. Prepare the filling as follows:
   a) Weigh or measure the flour and sugar. Mix them together and turn them into the top of a double boiler.
   b) Beat together the whole egg and the egg yolks; mix them with the flour and sugar.
   c) Grate the lemon rind. Measure the lemon juice. Stir them with the flour-sugar-egg mixture.
   d) Weigh or measure the milk. Heat it, but do not let it come to the boiling-point. Stir it frequently to prevent scorching. As soon as it is hot, stir it into the flour-sugar-egg-lemon mixture slowly to prevent lumping. Be sure the ingredients that cling around the edge of the pan are mixed with the rest.

[1] Juice from $2\frac{1}{2}$–3 lemons.

Cook this mixture in the double boiler for about 15 minutes. Stir it constantly until it thickens. Then cover the double boiler.

e) Beat the egg white until it is stiff. Immediately pour about a tablespoon of the hot mixture over the surface of the white, and with a spoon, beat until the two are well mixed. Combine 4 or 5 more tablespoons of the hot filling with the egg white in the same manner; then pour this egg-white mixture slowly into the hot filling, stirring the latter vigorously during the addition.

Cook the filling for about 2 minutes, or until it is sufficiently thick that a spoonful, when removed and turned back, falls in ridges which do not flatten out for about a minute.

f) Remove the filling from the fire; beat until smooth; then pour into the pie crust.

3. With the two egg whites left over from the filling, prepare a meringue according to the directions given on page 129. Spread this meringue over the filling; brown it in an oven at 300° F.
4. Do not cut the pie until it is cold. Serve it on the same day that it is prepared.

COCOANUT CREAM OR BANANA CREAM PIE

Proportion of ingredients

a) For the crust

	WEIGHT IN GRAMS	APPROXIMATE MEASURE
Flour		
Pastry	96.0	1 cup
or		
Family	84.8	$\frac{3}{4}$ cup
Salt		$\frac{1}{2}$ teaspoon
Solid fat (cold)	38.1	3 tablespoons
Water (cold)	28 to 33	28 to 33 cubic centimeters (2 tablespoons)

Proportion of ingredients—*Continued*

	WEIGHT IN GRAMS	APPROXIMATE MEASURE
b) For the filling		
Flour		
Pastry	24.0	4 tablespoons
or		
Family	24.0	$3\frac{1}{2}$ tablespoons
Sugar	100.0	$\frac{1}{2}$ cup
Egg		
Yolks	54.0	3 medium sized
White	30.0	1 medium sized
Milk	325.3	$1\frac{1}{3}$ cups (315 cubic centimeters)
Vanilla		$\frac{1}{2}$ teaspoon
Shredded cocoanut	70.0	$\frac{3}{4}$ cup
or		
Bananas		2 medium sized

Order of work

1. Prepare the pie shell as follows:
   a) Mix the salt with the flour; cut the fat into this mixture; then add the water *slowly* until all the dry material is damp.
   b) Press this dampened material firmly together; roll into a sheet about $\frac{1}{16}$ inch in thickness; fit into a pie pan; bake until brown in an oven at 450° Fahrenheit. As soon as the crust is baked, lower the oven regulator to 300° F.
2. Prepare the filling as follows:
   a) Weigh or measure the flour and sugar. Mix them together and turn them into the top of a double boiler.
   b) Separate the egg whites from the yolks. Set two of the whites aside for the meringue. Place the other in a bowl in which it can be beaten conveniently. Beat the yolks slightly.
   c) Weigh or measure the milk. Heat it, but do not let it come to the boiling-point. Stir it frequently to prevent scorching. As soon as it is hot, stir about one-fourth of

it slowly into the flour-sugar mixture; then beat the mixture until it is smooth. Add the egg yolks and mix them well with the other ingredients. Add the rest of the milk gradually with constant stirring.

Cook this mixture in a double boiler for about 15 minutes. Stir it constantly until it thickens; then cover the double boiler.

d) Beat the egg white until it is stiff. Immediately pour about a tablespoon of the hot mixture over the surface of the white, and with a spoon beat until the two are well mixed. Combine 4 or 5 more tablespoons of the filling with the egg white in the same manner; then pour this egg-white mixture slowly into the hot filling, stirring the latter vigorously during the addition.

Cook this mixture for about 2 minutes; then remove it from the fire and cool it somewhat.

e) If cocoanut is to be used, cut it into pieces about 1 inch or so long, add about two-thirds of it to the filling and pour the filling into the crust.

If bananas are to be used, slice them over the crust, and then pour the filling on top of them.

3. With the egg whites left from the filling, prepare a meringue according to the directions given on page 129. Spread it over the filling. If cocoanut is being used, sprinkle the rest of it over the surface of the meringue. Brown the meringue at 300° F.
4. Do not cut the pie until it is cold. Serve it on the same day that it is prepared.

PINEAPPLE CREAM PIE

Proportion of ingredients

a) For the crust

	WEIGHT IN GRAMS	APPROXIMATE MEASURE
Flour		
Pastry	96.0	1 cup
or		
Family	84.8	$\frac{3}{4}$ cup

Proportion of ingredients—*Continued*

	WEIGHT IN GRAMS	APPROXIMATE MEASURE
Salt		$\frac{1}{2}$ teaspoon
Solid fat (cold)	38.1	3 tablespoons
Water (cold)	28 to 33	28 to 33 cubic centimeters (2 tablespoons)
b) For the filling		
Flour		
Pastry	30.0	5 tablespoons
or		
Family	30.0	4 tablespoons
Sugar	133.5	$\frac{2}{3}$ cup
Egg yolk	36.0	2 medium sized
Milk	325.3	$1\frac{1}{3}$ cups (315 cubic centimeters)
Crushed pineapple, drained		$\frac{3}{4}$ cup ($\frac{3}{4}$ of a $1\frac{1}{4}$-pound can)

Order of work

1. Prepare the pie shell as follows:
   a) Mix the salt with the flour; cut the fat into this mixture; then add the water *slowly* until all the dry material is damp.
   b) Press this dampened material firmly together; roll into a sheet about $\frac{1}{16}$ inch in thickness and fit into a pie pan; bake until brown in an oven at 450° Fahrenheit. As soon as the crust is baked, lower the oven regulator to 300° F.
2. Prepare the filling as follows:
   a) Weigh or measure the flour and sugar. Mix them together and turn them into the top of a double boiler.
   b) Separate the egg whites from the yolks. Beat the yolks slightly.
   c) Weigh or measure the milk. Heat it, but do not let it come to the boiling-point. Stir it frequently to prevent scorching. As soon as it is hot, stir about one-fourth of

it slowly into the flour-sugar mixture; then beat the mixture until it is smooth. Add the egg yolks and mix them well with the other ingredients. Add the rest of the milk gradually, with constant stirring.

Cook this mixture in a double boiler for about 15 minutes. Stir it constantly until it thickens. Then cover the double boiler.

d) Press as much liquid as possible out of the pineapple. Measure the pineapple.

e) Remove the filling from the fire; beat until smooth; cool somewhat; add the pineapple; and turn into the shell.

3. With the two egg whites left from the filling, prepare a meringue according to the directions given on page 129. Spread this meringue over the filling; brown it in an oven at 300° F.
4. Do not cut the pie until it is cold. Serve it on the same day that it is prepared.

APPLE PIE

Proportion of ingredients

a) For the crust

	WEIGHT IN GRAMS	APPROXIMATE MEASURE
Flour		
Pastry	192.0	2 cups
or		
Family	169.6	$1\frac{1}{2}$ cups
Salt		1 teaspoon
Solid fat (cold)	76.2	6 tablespoons
Water (cold)	60 to 66	60 to 66 cubic centimeters ($\frac{1}{4}$ cup)

b) For the filling

Tart apples (sliced)	567.0	4 cups (about 4 rather large apples)
Sugar	50.0	4 tablespoons
Butter	13.1	1 tablespoon
Nutmeg and cinnamon, if desired		$\frac{1}{2}$ teaspoon, each

Order of work

1. Prepare the pie crusts as follows:
   a) Mix the salt with the flour; cut the fat into this mixture; then add the water *slowly* until all the dry material is damp.
   b) Divide this dampened material into halves, and press the particles of each half firmly together. Roll one half into a sheet about $\frac{1}{16}$ inch thick; then line a pie-pan with it. Roll the other half into a similar sheet, and cut a design in it.
2. Quickly wash, pare, and slice the apples. Spread approximately a third of them in a layer over the bottom crust. Sprinkle about 1 tablespoon of the sugar and 1 teaspoon of the butter, the latter cut into small pieces, on top of the apples. In the same manner arrange two more layers on top of the first. If spices are being used, sprinkle them on top of the last layer of apples. The filling will round up above the crust.
3. Light an oven. Turn it to 425° Fahrenheit.
4. Dampen the edge of the lower crust; place the upper crust upon the filling; press the edge of the upper crust firmly onto the lower; trim off the extra pastry.
5. Bake the pie at 425° F. for about 10 minutes; then at 350° F. until the apples are tender and the crust is a golden brown. The apples are tender when a toothpick stuck through one of the holes in the upper crust goes into the apples easily.

RAISIN PIE

Proportion of ingredients

a) For the filling

	WEIGHT IN GRAMS	APPROXIMATE MEASURE
Raisins	320.0	2 cups ($\frac{3}{4}$ of a 15-ounce package)
Lemon juice		$\frac{1}{4}$ cup (juice of about 2 lemons)

Proportion of ingredients—*Continued*

	WEIGHT IN GRAMS	APPROXIMATE MEASURE
Lemon rind (cut into small pieces)		½ lemon rind
Water	355 to 473	1½ to 2 cups
Sugar	100.0	½ cup
Flour	12.0	2 tablespoons
b) For the crust		
Flour		
Pastry	192.0	2 cups
or		
Family	169.6	1½ cups
Salt		1 teaspoon
Solid fat (cold)	76.2	6 tablespoons
Water (cold)	60 to 66	60 to 66 cubic centimeters (¼ cup)

Order of work

1. Prepare the filling as follows:
   a) Weigh or measure the raisins. Cut the lemon rind in small pieces and add it to the raisins. Soak this mixture over night in the smaller amount of water (1½ cups) if the raisins are moist, or in the larger (2 cups) if they are dry.
   b) Cook in a small pan (about 1½ quarts) for about 20 minutes, or until the raisins are tender. At the end of the cooking-period there should be left approximately ½ cup of liquid. If there is more, evaporate the excess; if there is less, add water.
   c) Weigh or measure the sugar and flour, mix them, then stir them with the raisins until all are well combined.
   d) Return this mixture to the fire and heat it just to the boiling-point. Stir it continually to prevent burning. As soon as it has come to the boil, remove it from the fire and set it aside to cool. Then add the lemon juice.

2. Prepare the crusts as follows:
   a) Mix the salt with the flour, cut the fat into this mixture, then add the water *slowly* until all the dry material is damp.
   b) Divide this dampened material into halves, and press the particles of each half firmly together. Roll one half into a sheet about $\frac{1}{16}$ inch thick, then line a pie pan with it. Roll the other half into a similar sheet, and cut a design in it.
3. Light an oven, turn it to 425° Fahrenheit.
4. Pour the filling into the lower crust, and dampen the edge of the crust; place the upper crust upon the filling; press the edge of the upper crust firmly onto the lower; trim off the extra pastry.
5. Bake the pie at 425° F. until the crust is a golden brown (30 to 35 minutes).

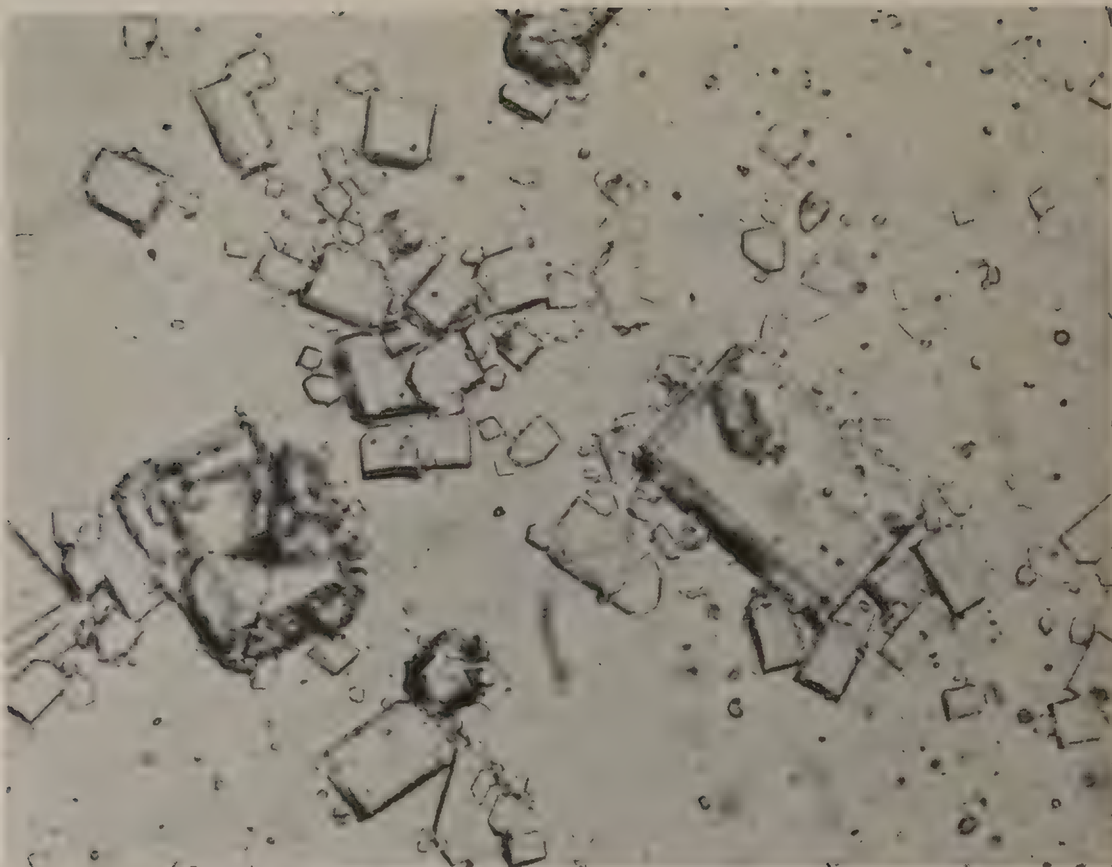


FIG. 27.—Crystals from fondant in which the sirup was beaten while hot (temperature 103° C.). Huge crystals like these mean a very granular, coarse, and crumbly candy. Magnification approximately ×200.

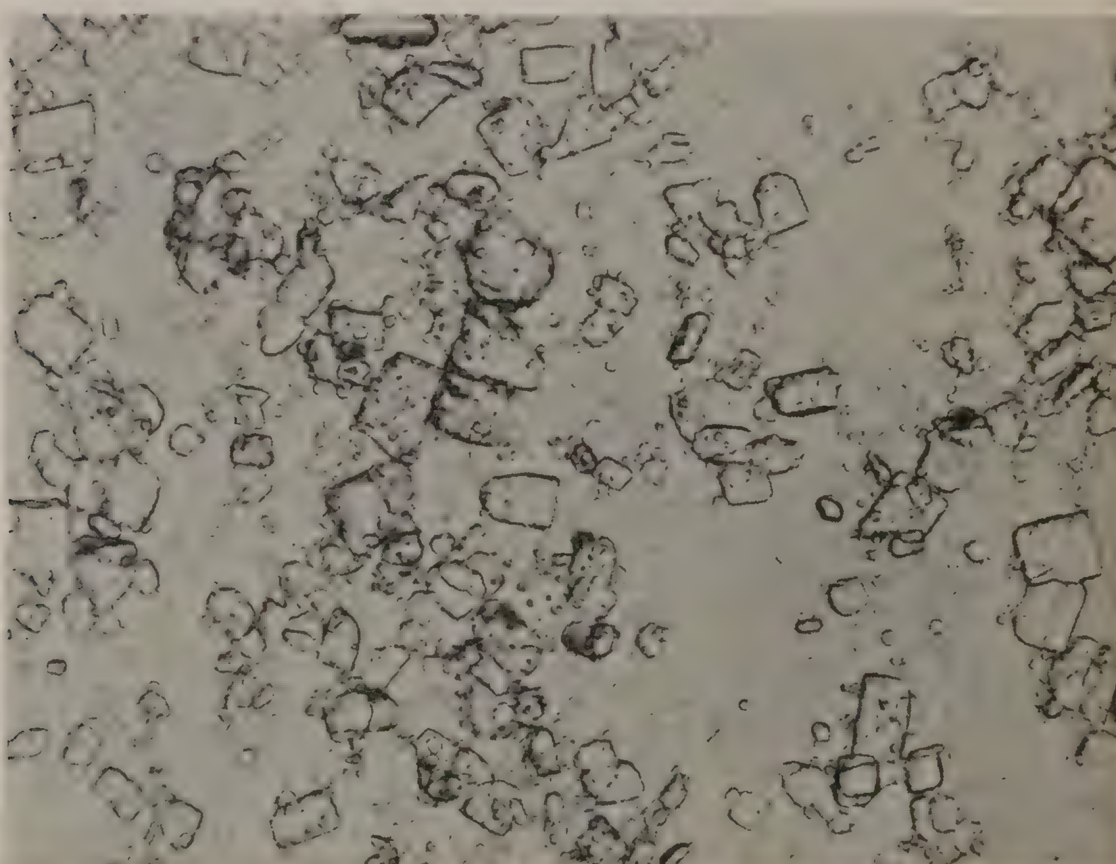


FIG. 28.—Crystals from fondant in which the sirup was cooled somewhat (temperature 70° C.) before beating. These crystals, although smaller than the ones shown in Figure 27, are still so large that they make a coarse candy. Magnification approximately ×200.

CHAPTER VIII

CANDY

There are two general types of candies—crystalline, such as fondant and fudges; and non-crystalline or amorphous, such as butterscotch and caramels. In the former type, we want very small sugar crystals, so small that they are not perceptible to the tongue—in other words, so small that the candy feels smooth and velvety on the tongue and we do not suspect that crystals are present until the microscope reveals them. Moreover, we want the crystals to remain small as long as the candy lasts. In amorphous candies, we want no crystals when the candy is first made; nor do we want any to form on standing. If by chance crystals do form, the candy loses the consistency we have come to associate with it and becomes wholly undesirable. Caramels, for example, which become crystalline lose their waxy or "chewy" consistency and are no longer caramels.

The problem of candy-making is thus largely one of learning how to obtain small sugar crystals in the one type and none at all in the other.

CRYSTALLINE CANDY

EFFECT OF COOLING BEFORE BEATING

In all candies of this type, crystallization is induced by agitation or beating, and it is the temperature of the candy solution at the time of beating, which more than any other factor is responsible for the size of the crystals formed. This can be shown easily enough by boiling sugar and water together to a given temperature, then dividing the solution thus obtained into different portions and beating each at a different temperature. The photomicrographs[1] given in Figures 27 to 30 show what happens. Figure 27 is a picture of the crystals which formed in the solution which was beaten as soon as it was turned out of the pan, 103°

[1] Fondant and slides for Figures 27–36, inclusive, were prepared by Vida Wentz.

Centigrade; while Figures 28, 29, and 30 show those which formed in the solutions cooled to 70°, 60°, and 40° C., respectively, before beating. The magnification is the same for all of these photomicrographs (approximately 200 times); hence they show the relative size of the crystals formed at different temperatures, and they give definite visible evidence of the value of cooling in inducing small crystals to form.

EFFECT OF INCOMPLETE BEATING

Another point to be observed is that beating must be continued until crystallization is complete. Experience soon teaches one to recognize this stage, for it announces itself by a sudden softening followed by a stiffening. As all candy makers know, a well cooled sugar solution is very stiff and viscous and has a glossy appearance. When such a solution is beaten, however, it gradually grows opaque, then lighter in color, and finally, quite suddenly, it softens. Furthermore, the temperature changes as well as the stiffness and glossiness; the candy grows considerably warmer just as the softening occurs. In a large batch of candy, sufficient heat will be liberated to make the container feel perceptibly warmer to the hand. This heat means simply that a large amount of sugar has changed from a solution to a solid, a change in state which is accompanied by an evolution of heat just as is the change of water to ice. This latter fact is well known and sometimes put to practical use by setting tubs of water in root cellars on very cold nights, the heat given off from the freezing water being sufficient to raise the temperature of the cellar to a point above the freezing-temperature of the vegetables. When all the sugar has crystallized out of the candy solution, no more heat is given off and the mixture begins to cool and stiffen. It is at this stage that one should stop beating and turn the candy out.

In the recipes which follow, we have tried to make conditions such that the necessary beating-period would be so short that no one would be tempted to stop too soon. This is not true of all recipes, however, as many of us know. The writers have had the exasperating experience of beating a candy mixture a full

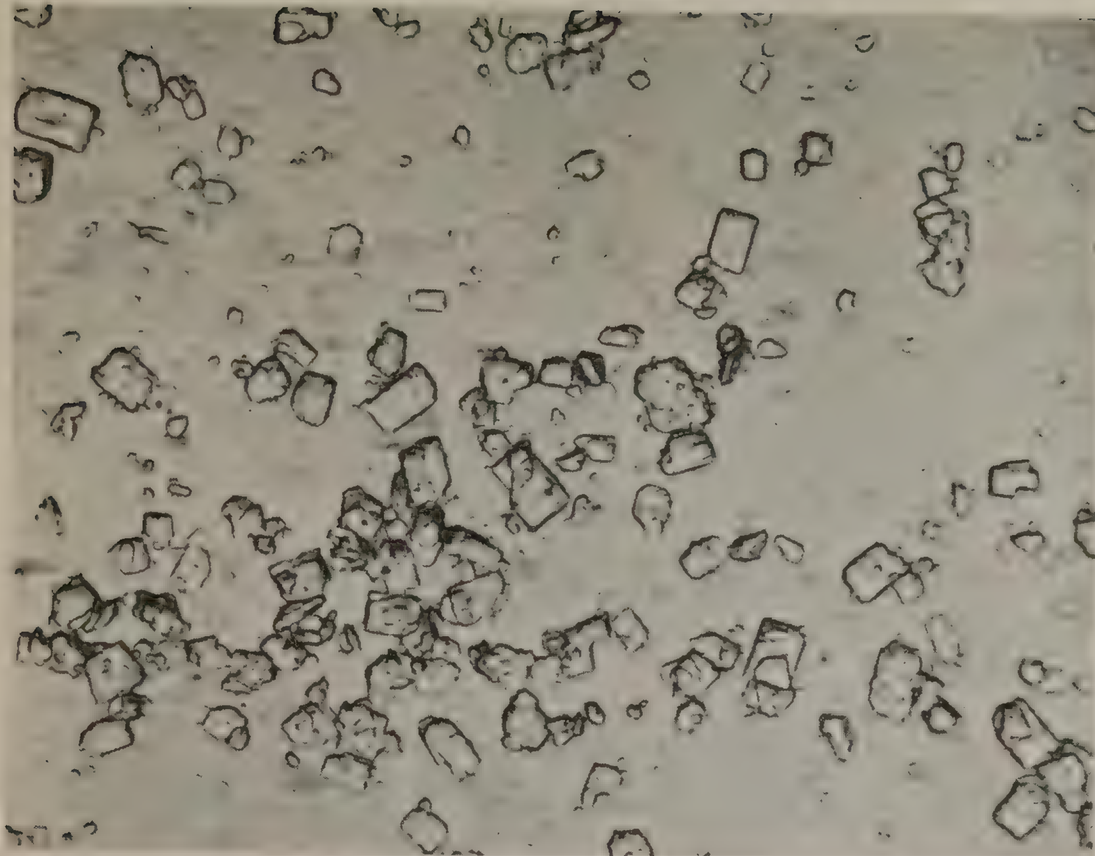


FIG. 29.—Crystals from fondant in which the sirup was cooled to 60° C. before beating. Even though these crystals are much smaller than the ones of Figure 27 and somewhat smaller than those of Figure 28, they are still so large that they form a "sugary" candy. Magnification approximately ×200.

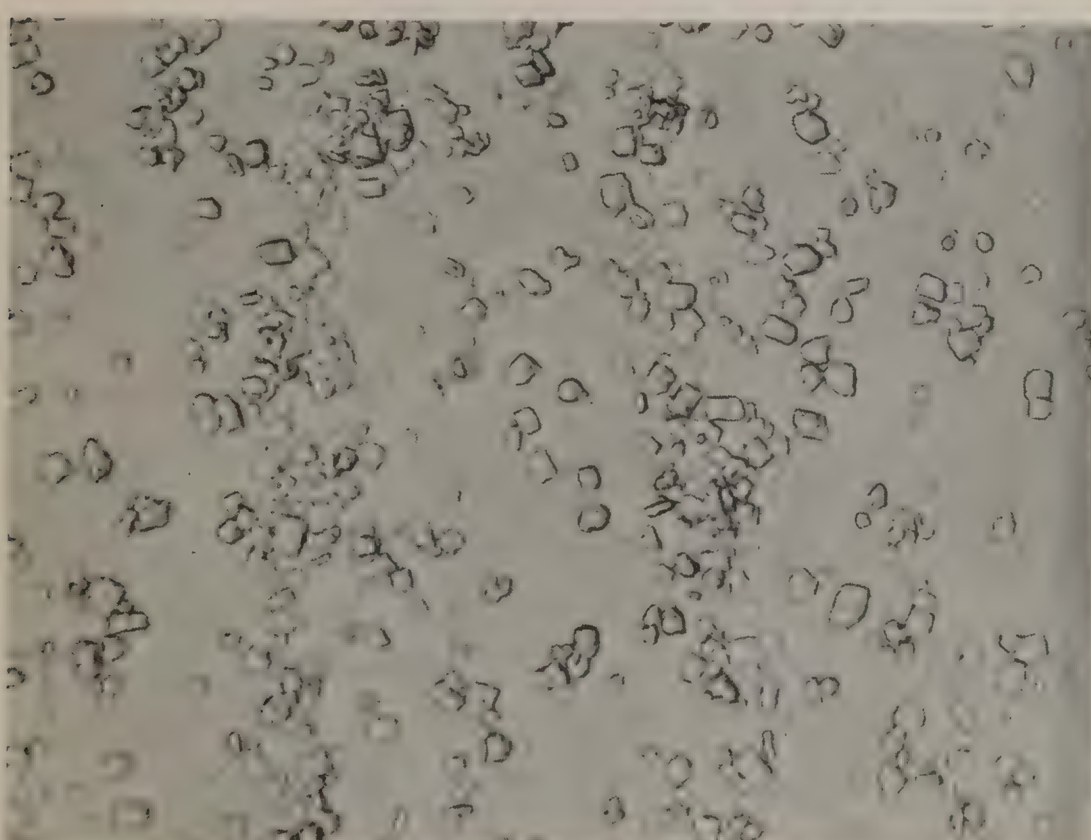


FIG. 30.—Crystals from fondant in which the sirup was cooled until it felt just warm to the hand (40° C.). Notice that these crystals are a great deal smaller than any yet shown. They are small enough to produce a pliable, creamy candy. Magnification approximately ×200.

FIG. 31.—Crystals from fondant in which the sirup was not beaten long enough for it to stiffen. Large crystals like these form whenever fondant (or fudge) is poured into the cooling pan too soon, and hardens only upon long standing. Magnification approximately ×200.

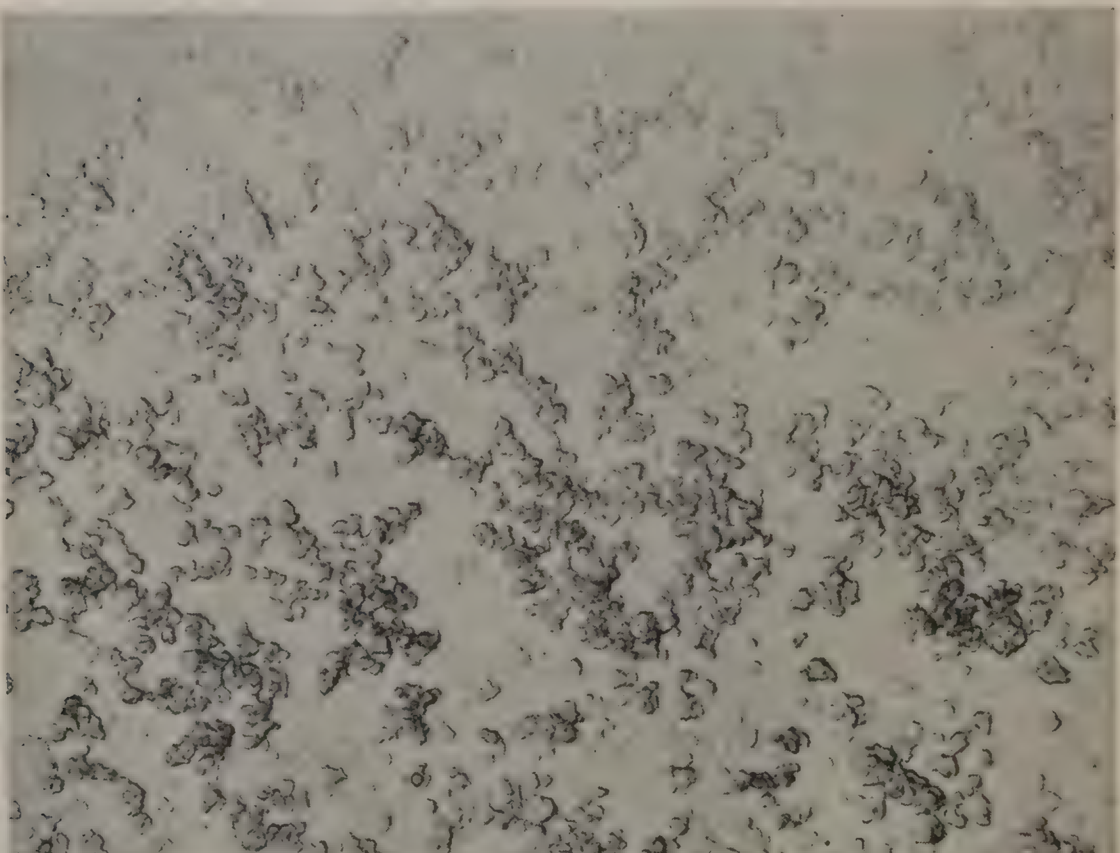


FIG. 32.—Crystals from the same batch of fondant as those shown in Figure 31. However, with this part of the sirup, the beating-period was continued until the candy had become stiff—in other words, until crystallization was complete. Magnification approximately ×200.

half-hour or longer without its having reached the sudden softening followed by stiffening stage. Then, being too weary to continue, we have finally turned it out, to find that upon standing it had become coarsely crystalline, so coarse that the crystals were perhaps visible to the naked eye—at any rate, perceptible to the tongue. Figures 31 and 32 show samples of the very same batch of candy, Figure 31 representing that removed *before* and Figure 32 that removed *after* complete crystallization had occurred.

USE OF FOREIGN MATERIALS

In order to obtain very small crystals, and especially crystals which will remain small through a considerable period, such as that which elapses between the time Christmas candies are made and eaten, certain foreign substances will have to be added to the sugar and water mixture. For fondant, this foreign material is usually corn sirup or some kind of acid, such as cream of tartar; for fudge, it is either corn sirup and cream, or corn sirup, milk, and butter. Such substances appear to act as interference during crystallization and make it difficult for sugar molecules to collect in groups of sufficient size to form large crystals. The effect of one of them (or rather of the products formed by it [page 142] can be seen by comparing the size of the crystals in Figure 33, representing candy made from sugar and water alone, with the appreciably smaller ones of Figure 35, in which cream of tartar was used.

The work of foreign materials does not cease at the time when the crystals form but continues during the storage period and tends to retard crystal growth. No matter how small the crystals are when formed, they are never uniform in size; some are bound to be larger than others. On standing, if nothing is present to interfere with the natural course of events, the large crystals, like large corporations in the presence of small ones, grow larger, while the small ones tend to disappear. This tendency is well brought out by the crystals shown in Figures 33 and 34, representing fondant made from sugar and water. Those of Figure 33 were photographed immediately after the candy was made; those of Figure 34, seventeen days later. It will be observed that the

crystals of the stored fondant are perceptibly larger than the ones of the fondant just made.

By contrasting the crystals of Figures 33 and 34 with those shown in Figures 35 and 36, the effect of foreign material in retarding crystal growth is seen. The fondant of Figure 36, like that of Figure 34, was photographed seventeen days after it was made; but, unlike that of Figure 34, it contained cream of tartar, and as a result the crystals show no material increase in size over the ones of the same kind taken immediately after the candy was made (Fig. 35).

Important as are foreign substances in the making of crystalline candies, there is such a thing as having too much of them, in which case we may not be able to induce crystallization at all, and if we do, it will be only after what seems endless beating. The danger of getting too much lies mostly in the use of acid. This is a point of considerable importance and calls for some discussion.

Acid.—First, it must be understood that it is not acid *as such* but rather the substances produced by acid from sugar which interfere with crystal formation and growth. These substances are glucose and levulose in equal quantities, a mixture which sometimes is given the name of "invert sugar." The levulose of the mixture is particularly efficient in preventing the formation and growth of crystals in candy; and if ever it is available in a pure state at a reasonable price, it will probably be used in large quantities in candy-making. At present the pure substance costs around forty dollars a pound; hence the only way we can hope to have it in candy is to make it on the spot along with its partner, glucose, from cane sugar, either by heating with acid as just mentioned, or by use of the enzyme invertase. The latter method is not practical for home candy-making, hence will not be discussed here. Its use, however, has certain advantages for commercial work, as is set forth in an article by Paine.[1]

The amount of invert sugar formed from sucrose at a given temperature depends chiefly on two variables—the concentration of the acid and the time through which it is allowed to act. At first

[1] "Constructive Chemistry in Relation to Confectionery Manufacture," *Industrial and Engineering Chemistry*, XVI (1924), 513.

FIG. 33.—Crystals from sugar-and-water fondant photographed as soon as prepared. Magnification approximately ×200.

FIG. 34.—Crystals from the same fondant as shown in Figure 33 photographed after standing 17 days. As may be noted by comparing these two figures, the crystals have grown larger upon standing. Magnification approximately ×200.

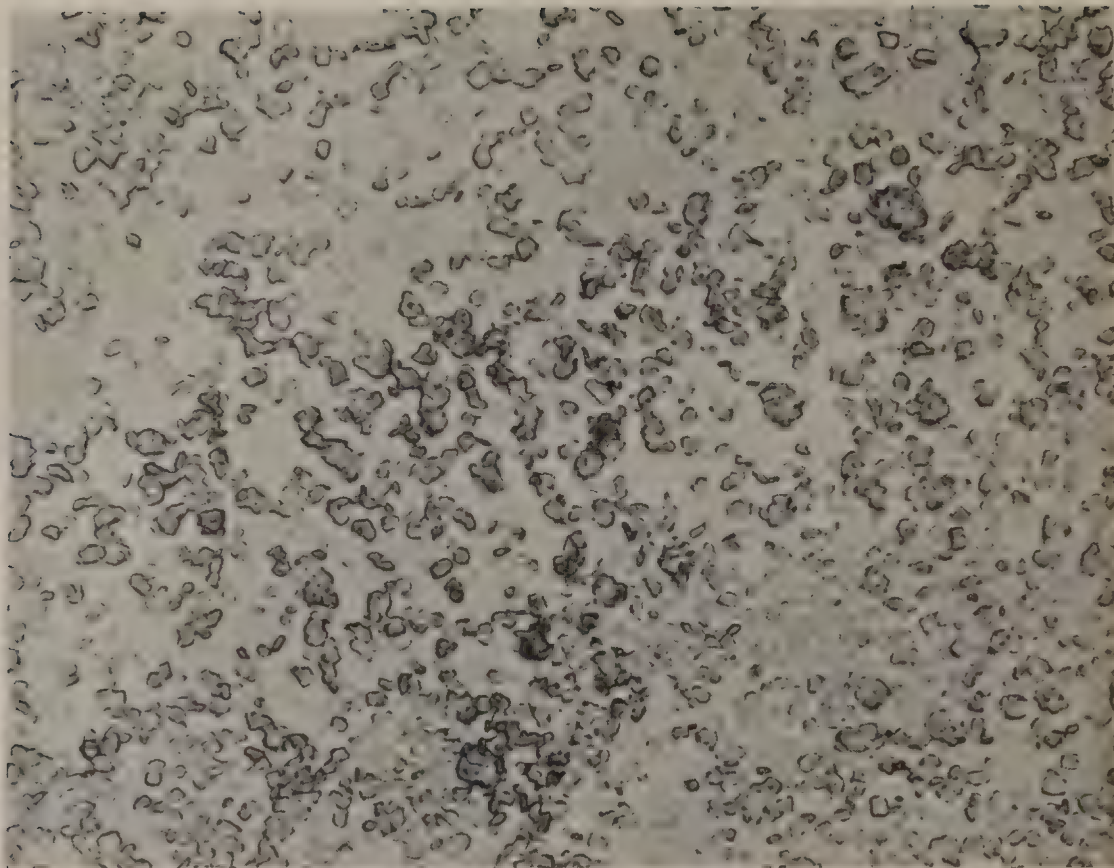


FIG. 35.—Crystals from sugar, cream of tartar, and water fondant, photographed as soon as prepared. A comparison of these crystals with those in Figure 33 shows that the use of cream of tartar in preparation of fondant decreases the size of the crystals formed and therefore makes a more creamy candy. Magnification approximately ×200.

FIG. 36.—Crystals from the same fondant as shown in Figure 35, photographed after standing 17 days. By comparing these crystals with those of Figure 35, it can be seen that cream of tartar tends to prevent the growth of crystals in fondant. Magnification approximately ×200.

thought it might seem easy enough to control the first of these, but such is not the case. Even if two candy-makers use exactly the same acid in exactly the same proportion, the acidity of their candy solutions may not be the same, because, as already stated in the vegetable discussion (page 5), most natural waters contain more or less free alkali and therefore neutralize some portion of the acid added. If the two workers chance to use water of the same alkalinity, well and good; if not, there is trouble. One way out of the difficulty is for everybody to use water which is practically pure, such as distilled or rain water, or that obtained by melting clean ice or snow, in which case all should obtain the same acid concentration if the ingredients used are carefully measured.

It will be noted that in our fondant recipe (page 149) we have given two proportions of acid, that for pure water and that for Chicago city water, which contains considerable free alkali, about as much as the most alkaline of the waters we have tested (p. 5). The chances are, then, that the proportion of acid which should be used with natural waters throughout the country is either the same as we use with Chicago water or less, but, of course, not less than the proportion given for pure water.

Fixing the concentration of acid, however, will not avail unless at the same time we make the length of the cooking-period a constant. Since in a hot solution the acid is busily at work changing sucrose to invert sugar, it follows that the longer we heat the solution the more invert sugar we shall have. It is, indeed, quite possible to get so much that our cooled solution crystallizes with great difficulty. We can duplicate our own or someone else's boiling period fairly well for given quantities of ingredients if we use kettles of similar size and shape and keep the solutions boiling briskly. Trouble comes in changing to a kettle of another shape—from a deep to a shallow one, or the other way around—and by this means changing the rate of evaporation, or in using different quantities of ingredients. Thus, one worker in our laboratory took twice the quantity of materials called for in the original recipe, and heated the mixture over a small gas burner, with the result that it took 40 minutes for the solution to reach the desired concentration as against 20 minutes for the small recipe. During this

long heating-period such a large amount of invert sugar was formed that it took 30 minutes' beating to induce crystallization in place of the usual 6 or 7 minutes.

In our fondant recipe, calling for cream of tartar, we have described the kettle used. If such a kettle is available and the mixture is kept boiling continuously, little difficulty should be encountered in duplicating our boiling-time.

Corn sirup.—Unlike acid, corn sirup, *as such*, interferes with the crystallization of cane sugar. One of its components is glucose, which is exactly the same as the glucose formed from cane sugar by the action of acid; another is dextrin, which closely resembles starch and forms a thick, viscous mixture when cooked.

In so far as they interfere with crystallization, corn sirup and invert sugar appear to be about equally effective, with the advantage slightly in favor of the latter. In certain other ways, however, corn sirup is to be preferred to invert sugar. With the former, one does not have to worry about the reaction of the water used, nor, within reason, the length of the boiling period, for regardless of these the substances present at the end of the cooking-period are the same as at the beginning. Furthermore, corn sirup picks up much less water in damp weather than does the levulose of invert sugar. In spite of these manifest advantages in the use of corn sirup, many of us, however, still cling to acid in making fondant because of the slightly better consistency given by invert sugar as against that given by corn sirup. Owing probably to its dextrin, the latter gives a fondant which tends to be somewhat viscous and sticky.

NON-CRYSTALLINE OR AMORPHOUS CANDY

In amorphous candies, such a large proportion of foreign substances are added that it is impossible for enough sugar molecules to get together to form one single crystal. In the brittle variety, of which butterscotch is an example, it is customary to use both corn sirup and an acid, usually vinegar or lemon juice. The acid is added to give flavor and to make the candy brittle rather than waxy, as would be the tendency if only corn sirup were used. One must be especially careful to use no more acid than the recipe

calls for and to keep the boiling-time short. Otherwise, so much invert sugar will be formed that in damp weather the candy will become sticky, owing to the tendency of the hydroscopic levulose to pick up water.

In waxy candies, such as caramels, huge quantities of three foreign materials—corn sirup, cream, and butter—are used. The only difficulty in making such candies is to cook to the desired consistency without scorching the mixture. This means constant stirring during the latter part of the cooking process.

CANDY TESTS

COLD-WATER TEST

The common household practice of cooking a candy solution until a cooled portion has the consistency of a soft or hard ball, or until it cracks, gives fairly good results for an experienced person. This is true in spite of the fact that there is no sharp distinction between one kind of ball and another and that as a consequence it takes rather a nice discrimination to select just that consistency which will give the best results. Such discrimination comes only with experience in correlating the look and feel of certain candy balls with certain results, good or bad, in the finished candy. The task of learning to do this is usually accompanied by a few failures, but the number of these can be greatly lessened if the beginner will carry out her tests as follows:

1. Use a small bowl freshly filled with cold water for cooling each sample of sirup. Cups and saucers, both of which candy makers are prone to use, are most unhandy, cups being of inconvenient shape for removing samples, and saucers being too shallow to permit proper cooling.

While the test is being made, set the pan of sirup off the fire. This is to prevent overcooking provided the desired consistency has been reached by the time the test is started.

2. Turn about half a teaspoon of the hot sirup into the bowl of cold water. Note how it behaves when it strikes the water. After it has cooled, pick it up to judge its consistency.

If the sirup stays together in one mass when it strikes the water, rather than scattering out or disappearing altogether, and

if it can be collected immediately and easily by the finger tips into a ball which feels very soft and flattens when laid upon the fingers, but yet shows no tendency to ooze between them, it has reached the soft-ball stage. This is the consistency for fondant and fudges.

If, when brought above the surface of the water, the ball feels plastic but yet is hard enough to hold its shape, the hard-ball stage has been reached.

If the sirup separates into threads when it strikes the water, and if these threads are hard but not brittle, the sirup has reached the consistency required for caramels.

THERMOMETER TEST

The most reliable method of testing a candy mixture is with the thermometer, but even this method can come to grief in the hands of the inexperienced or the unthinking. Probably the most common cause of trouble is faulty technique in reading the thermometer. To read it correctly, that part of the scale being read should be on a level with the eye; if it is below eye level, the reading is too high; if above, the reading is too low. Furthermore, when the reading is taken, the bulb of the thermometer should be completely covered by the liquid, not simply by the foam at the top; and it should not touch the pan at any point. And, of course, it should be read while the liquid is boiling. It may seem absurd that anyone should need such precautions, yet strangely enough a good many do. We have seen students who have been told to read the thermometer on the eye level, remove the pan from the fire and hold it in such a position that the right spot on the thermometer scale came opposite the eye, thus performing this part of the operation correctly, but at the same time introducing an error many times greater than could ever occur by reading the thermometer in the wrong position. Worse yet, we have seen them remove the thermometer from the boiling-solution and hold it up where it could be read conveniently, apparently not noticing that the mercury was making a swift descent toward its resting-place at room temperature.

Another possible source of error lies in the assumption that

there is one universal temperature which can be relied upon to give a "soft ball" or any other consistency for all candy solutions. This, of course, is not so. All that the temperature tells is the concentration, in other words, the number of particles present per unit volume. If two candy solutions boil at the same temperature the concentration may be the same, but not necessarily the consistency, for the latter depends upon the nature of the particles present as well as upon their number. For example, if we had two candy solutions boiling side by side, one containing considerable corn sirup along with cane sugar, the other cane sugar alone, and if we boiled the two to exactly the same temperature and tested their consistency by the cold-water test, we should find that the solution containing the corn sirup with its viscous, starch-like dextrin made a much stiffer ball than the one containing cane sugar alone. Thus it is that we can depend upon the temperature to indicate the consistency only for a certain definite combination of ingredients. In other words, a change in the recipe is likely to be accompanied by a change in the temperature of the candy test.

A third possible source of trouble in testing a candy solution with a thermometer is the failure to realize that each set of temperature tests holds good only for a given atmospheric pressure. This means slight temperature variations in candy tests from time to time, particularly in winter when the air pressure shows its greatest variation. In Chicago, for example, the pressure in 1927 ran anywhere from 726.4 to 764.5 millimeters of mercury, hence the boiling-point of water varied from 98.7 to 100.2° Centigrade, a difference of 1.5° C. (2.3° F.). Such differences should be taken into account in making candy tests if the latter are to be relied upon absolutely. Small differences can be corrected for with sufficient accuracy for our purpose by finding the temperature at which water boils and adding to that temperature the number of degrees above 100° C. called for in the candy test. Thus, if water boils at 98° C., a candy test of 115° C. would be corrected to read 113° C.

Such a correction also helps to take care of any error which may arise from faulty calibration of the thermometer.

The chances for error just discussed have been considered in

formulating the directions which follow for testing candy solutions with a thermometer.

Laboratory-thermometer test.—1. Select a thermometer with a short bulb, anywhere from ½ to ¾ inches in length, and preferably one with a long scale such as is found in those registering from 0° to 150° C. A short bulb is easily covered, even by small portions of candy; and a long scale is easily read, since in such scales the graduation marks are farther apart than in short ones.

2. Suspend the thermometer above the solution in such a way that its bulb is well covered by the liquid before boiling begins but so that it does not touch the bottom or side of the pan. To lessen the chances of breaking the thermometer, tie it in place with a string, thus leaving it free to swing if accidentally touched, and making it possible to move it to one side if the mixture is one that has to be stirred, such, for example, as caramels.

3. Keep the liquid boiling while reading the thermometer, and have the eye on the level with that part of the scale being read.

4. Take the temperature of boiling water and add to this temperature the number of degrees above 100° C. specified in the candy test.

Candy-thermometer test.—1. Attach the thermometer to the kettle at such a height that the bulb is well covered by the liquid before it starts to boil, but at the same time, at such a height that the thermometer frame does not touch the bottom of the kettle.

2. Keep the liquid boiling while reading the thermometer and have the eye on the level with that part of the scale being read.

3. Take the temperature of boiling water and add to this temperature the number of degrees above 212° F. specified in the candy test.

COMBINATION THERMOMETER–COLD-WATER TEST

In view of the difficulties involved in making an absolutely reliable thermometer test, some home candy-makers prefer to make a combination thermometer–cold-water test. This is done simply by boiling the candy to a temperature about three or four degrees lower than that called for in the directions, then removing the kettle from the fire and testing the sirup by the cold-water method. If the consistency does not appear to be the desired one,

the candy is put back over the fire and heated just to boiling, then retested. This process is repeated until the desired consistency is reached. By such a procedure as this, one soon becomes quite expert in judging the consistency required for various types of candy.

DIRECTIONS FOR THE PREPARATION OF CANDY[1]

GRANULATED-SUGAR FONDANT

Yield

About $1\frac{1}{4}$ pounds.

Utensils

Cooking pan: capacity, 2 quarts; the one used in this laboratory is $6\frac{1}{2}$ inches in diameter.

Cooling dish: a smooth platter or shallow glass baking dish of at least 1-quart capacity.

Proportion of ingredients

a) For cream-of-tartar fondant

	WEIGHT IN GRAMS	APPROXIMATE MEASURE
Sugar	600.0	3 cups
Cream of tartar		
When distilled (or rain) water is used	0.4	$\frac{3}{16}$ teaspoon
When slightly alkaline (pH 8.4 to 8.6) water is used	0.8	$\frac{3}{8}$ teaspoon
Boiling water	355.0	$1\frac{1}{2}$ cups
b) For corn-sirup fondant		
Sugar	600.0	3 cups
White corn sirup	30.0	2 tablespoons
Boiling water	355.0	$1\frac{1}{2}$ cups

Order of work: detailed form

1. Weigh or measure the sugar and the cream of tartar or corn sirup; turn them into the cooking pan.

[1] Measurement of the ingredients used in candy will give proportions sufficiently accurate for home cooking. Cream of tartar, if not weighed, however, should be measured carefully.

2. Weigh or measure the boiling water. Stir it with the sugar mixture until all of the sugar has dissolved. If the last of the sugar does not go into solution easily, the sirup may be heated over a low flame. Stop stirring as soon as the sugar has dissolved, and do not stir the mixture again.
3. When a thermometer is used, place it in such a position that its bulb is covered by the sirup but does not touch the pan.
4. Set the dish in which the sirup is to be cooled in a warm place.
5. Cook the sirup as follows:
    a) Bring quickly to the boil and boil briskly. If a gas burner is being used, regulate the flame so that it comes in contact with the entire bottom surface, but not with the sides, of the pan.

        In cream-of-tartar fondant, the amount of heat should be so regulated that the cooking-period takes about 20 minutes.
    b) With a damp cloth wrapped around the tines of a fork, remove any crystals that collect above the sirup.
    c) Cook to the soft-ball stage (115° C. [239° F.]). (For method of testing for this stage, see page 145.) Remove from the fire, let stand in the pan until all the bubbles have disappeared, then pour into the cooling dish as much of it as will drain from the pan of its own accord. (Do not scrape the pan, for such agitation will cause crystallization to start.)
6. Cool the sirup as follows:
    a) Set it on a rack where it may cool from the bottom as well as from the sides.
    b) Cool to 40° C. (104° F.) or until the platter can be held comfortably upon the hand. At room temperature, this will take about 45 minutes.
7. With a wooden spoon, beat the sirup until it becomes white and solid enough to handle (about 5 minutes), then pick it up and work it with the hands until all lumps have disappeared. Place it in a jar, cover it with a damp cloth and

with the lid of the jar. Let it stand for about 24 hours before using.

Order of work: Abbreviated form

If the person who makes this candy chooses to use cream of tartar and distilled (rain) water, and to measure the ingredients, a résumé is somewhat as follows:

1. Proportion of ingredients

Sugar	3 cups
Cream of tartar	$\frac{3}{16}$ teaspoon
Boiling water	$1\frac{1}{2}$ cups

2. Mix the three ingredients together, being sure that the sugar is completely dissolved before the sirup reaches the boiling-point.
3. Cook to the soft-ball consistency (115° C. [239° F]) in about 20 minutes.
4. Pour into a warm, fairly shallow baking dish and cool to 40° C. (104° F.).
5. Beat, then knead.

BROWN-SUGAR FONDANT

Yield

About $1\frac{1}{2}$ pounds.

Utensils

Cooking pan: capacity, 2 quarts; the one used in this laboratory is $6\frac{1}{2}$ inches in diameter.

Cooling dish: a smooth platter or shallow glass baking dish of at least 1-quart capacity.

Proportion of ingredients

	WEIGHT IN GRAMS	APPROXIMATE MEASURE
Light-brown sugar	390	2 cups
Granulated sugar	400	2 cups
Boiling water	473	2 cups

Order of work

1. Weigh or measure the ingredients. Turn them into the cooking pan, and stir until the sugar has dissolved. If the

last of the sugar does not go into solution easily, the sirup may be heated over a low flame. Stop stirring as soon as the sugar has dissolved, and do not stir the mixture again.

2. When a thermometer is used, place it in such a position that its bulb is covered by the sirup but does not touch the pan.
3. Set the dish in which the sirup is to be cooled in a warm place.
4. Cook the sirup as follows:
   a) Bring quickly to a boil and boil briskly. If a gas burner is being used, regulate the flame so that it comes in contact with the entire bottom surface, but not with the sides, of the pan, and, moreover, so that the cooking-period takes about 20 minutes.
   b) With a damp cloth wrapped around the tines of a fork, remove any crystals that collect above the sirup.
   c) Cook to the soft-ball stage (115° C. [239° F.]). (For method of testing for this stage, see page 145.) Remove from the fire, let stand in the pan until all the bubbles have disappeared, then pour into the cooling dish as much of it as will drain from the pan of its own accord. (Do not scrape the pan, for such agitation will cause crystallization to start.)
5. Cool the sirup as follows:
   a) Set it on a rack where it may cool from the bottom as well as from the sides.
   b) Cool to 40° C. (104° F.) or until the platter can be held comfortably upon the hand. At room temperature this will take about 45 minutes.
6. With a wooden spoon, beat the sirup until it loses its stickiness and becomes a light-brown creamy mass solid enough to handle (6 or 7 minutes), then pick it up and work it with the hands until all lumps have disappeared. Place it in a jar, cover it with a damp cloth and with the lid of the jar. Let it stand for about 24 hours before using.

FONDANT CONFECTIONS

Fondant is used in the preparation of a great variety of confections, a few of which will be discussed here.

BONBONS

Bonbons are two-layer candies—one layer being of molded fondant, with or without the addition of fruit or nuts; the other of melted fondant, usually colored, which hardens to give a smooth, glossy covering. The processes involved in making bonbons are coloring and flavoring the fondant, preparing the centers, melting the fondant for dipping the centers, and finally dipping them. Each of these processes is discussed separately.

Coloring fondant.—We use Burnett's pastes for coloring candy. These pastes can usually be obtained from a local grocer, or confectioner; but if not, then from the manufacturer. They are concentrated and must be used in very small quantities indeed, if the candy is to be delicate and attractive in appearance rather than vivid and poisonous looking. To make sure that we do not use too much, we add them from the point of a toothpick.

If the fondant is for centers and is *not* melted, we work the coloring in with the hands by adding just a little bit at a time, working each portion in before adding another, repeating the process until the desired shade is reached. Such centers are usually not dipped but are rolled in cocoanut or chopped nuts. If the fondant is for dipping and therefore melted, we add the coloring during the melting process, a small portion at a time as for the unmelted.

The colors usually preferred for bonbons are rose, green, and yellow—all in delicate pastel shades.

Flavoring fondant.—The flavoring is added at the same time as the coloring, and, in case of peppermint, wintergreen, or other concentrated substances, in very small portions to avoid using too much.

Shaping bonbon centers.—Bonbon centers may be shaped by rolling small pieces of the prepared fondant between the palms of the hands with a rotary motion to form small balls. A convenient size is three-fourths of an inch in diameter, which means

that the finished bonbon is about an inch across. After shaping, the centers are allowed to stand from 3 to 12 hours—the time depending on the weather and one's convenience—in order to crust the outside so that they will keep their shape when dipped.

In general, it is desirable to add fruit or nuts or a combination of the two to fondant centers, since those made of fondant alone are oversweet. Suggestions for single additional substances and for combinations are given on page 156. If any of these are used, they should be worked into the fondant along with the coloring and flavoring.

Dipping bonbons.—(*a*) Utensils: We use an improvised double boiler for melting the fondant and dipping the bonbons. This consists of two shallow pans fitted together, one slightly larger than the other, the inner one with a capacity of about a pint. Such an arrangement is more convenient than a regular double boiler with its deep inner pan from which bonbons are very awkwardly removed.

For turning the bonbons and lifting them from the melted fondant, we use a dipper copied by a laboratory technician from one in the possession of Ruth Lehman of this department. It consists of a piece of heavy wire looped and sealed into a metal handle. The loop is 2 inches long and ½ wide, outside measure; the handle is 6 inches long. Before we acquired this dipper, we used a steel fork from which the center tines had been removed.

For receiving the coated centers, we use a molding board covered with waxed paper. From such a surface the bonbons can be removed without fear of cracking their delicate outer shells.

b) Melting the fondant: We use about three fourths of a pound (1 cup) of dipping fondant at a time. This fills the inner pan of our improvised double boiler just about half full. Less than this is soon reduced to the point where it will not coat the bonbons evenly and, moreover, cools so rapidly that it must be reheated frequently. If much more is used, quite a large quantity will have to be discarded at the last because it has become grainy with the constant agitation occasioned by dipping the bonbons.

During melting, the unsoftened fondant will have to be turned over from time to time but should be stirred very little, for

agitation causes the formation of large crystals. Such crystals are particularly undesirable in colored bonbons because they form white patches which give the candy a mottled effect.

As soon as the lumps have disappeared and the whole mass has become mobile, but is still thick—about the consistency of cold corn sirup—the fondant has melted sufficiently to be used for dipping, and is ready to be removed from the hot water and placed near the waxed-paper-covered surface prepared to receive the bonbons.

c) Coating the centers: A center is picked up with the fingers and dropped right side up—that is to say, rounded side up—into the melted fondant and is immediately turned over gently with the candy dipper. During the turning process it should be completely coated with melted fondant; if it is not, there is insufficient fondant in the pan. After the turning, the dipper is slipped under the candy in such a manner that the rounded side rests upon it. In this position, the two are brought out of the molten material, are held above the pan until the draining fondant drops in long fine threads, and then are carried to the waxed paper. When about an inch above the paper, the piece of candy is quickly inverted, so that for a moment it hangs from the dipper. Soon, however, it drops right side up, onto the paper. As it does so, it may break away sharply from the fondant clinging to the dipper, or it may spin a thread which can be wound as a design upon the top of the bonbon.

After the candy leaves the dipper, the coating should be stiff enough so that it remains on the bonbon in a thick layer. If it runs off, forming a base around the candy, the dipping fondant is too hot and should be cooled for a few minutes before being used again. If, on the other hand, the coating is not smooth and glossy but tends to be rough and uneven, the dipping fondant has become too cool, and should be remelted.

Sometimes it happens that fondant, after having been melted once, does not soften upon heating again, but remains dry and crumbly. If this occurs, a few drops of hot water will cause it to soften. The water must be added slowly drop by drop, for very little is required to moisten the candy and an excess will make it

too soft. The last little bit of fondant left in the dipping pan usually hardens, but this small amount is seldom worth the trouble of remelting, for almost invariably it has become grainy and therefore undesirable.

The bonbons should not be removed from the waxed paper until their coatings are perfectly solid.

SUGGESTIONS FOR BONBONS AND THEIR DERIVATIVES

A. Suggestions for centers:
   1. White-sugar fondant, flavored, uncolored
   2. White-sugar fondant, flavored, colored
   3. White-sugar fondant, flavored, plus:
      a) Half, quarter, or chopped nut meats
      b) Shredded cocoanut
      c) Candied fruit (either mixed with the fondant or placed in the center of the fondant):
         1) Cherries
         2) Pineapple
      d) Dates[1]
      e) Dried figs
      f) Combinations of any of the above, as a date-fig-nut mixture
   4. Brown-sugar fondant, either alone or mixed with any of the things mentioned under (3)
   5. Brown-sugar fudge, alone or mixed with any of the substances mentioned under (3)

B. Suggestions for coverings for centers:
   1. Covered before hardening:
      a) Roll in almonds which have been prepared by blanching, drying, browning and then chopping
      b) Roll in chopped, shredded cocoanut
   2. Allowed to harden, then covered by dipping into melted fondant or fudge:
      a) White fondant, different flavors
      b) Tinted fondant, different flavors
      c) Brown-sugar fondant

[1] Dark-colored centers should be covered with a coating which masks their color, as brown-sugar fondant or fudge.

d) Brown-sugar fudge
e) Chocolate fudge
f) Dipped into any of the above fondants or fudges and rolled immediately after dipping in chopped almonds or shredded cocoanut

CANDY LOAF

Another decorative use for fondant is candy loaf which is fashioned in layers like brick ice-cream. A pleasing combination for this is two layers of fondant, one white, the other rose colored, with a layer of brown-sugar, nut fudge in the center. Three layers of fondant may, of course, be used, in which case we suggest that the center one contain nuts or some kind of fruit, such as dates, figs, or candied fruit.

If one has the fondant prepared, the next step is the selection of a pan for molding it, preferably one about $1\frac{1}{2}$ inches deep. This depth is sufficient to show off the three colored layers advantageously, when cut. The capacity of the pan should be determined in order to know approximately the quantity of fondant or fudge to allow for each layer. For example, if the tin holds 4 cups of water, a total of 4 cups of candy are required. This amount can be apportioned as desired, but the result is a little more pleasing if the top and bottom layers are of approximately the same thickness.

In order to enable one to handle the candy easily when it is ready to be cut, the pan in which it is molded should be lined with heavy waxed paper which stands an inch or two above the rim.

When the pan is ready, the fondant is melted for the bottom layer over hot water in any sort of double-boiler arrangement that is convenient; flavored and colored, according to the directions under bonbons; turned out and spread over the entire surface of the pan in a fairly even layer. Any time after the first layer cools enough to set, the second layer is added, and similarly the third. If the second layer is fudge, it can be turned directly into the pan as soon as it is beaten, provided the bottom layer is ready at that moment to receive it. If not, and it cools, it will have to be melted in the same manner as fondant.

When ready to be cut, the loaf is lifted out of the pan and cut into slices about $\frac{1}{2}$ inch wide, which are again divided into sections about $1\frac{3}{4}$ inches long. If the candy is to be packed, or kept any length of time, the sections should be wrapped in heavy waxed paper in order that they may retain their shape and not dry out.

MINTS

After-dinner mints, like other fondant confections, may be flavored and colored to suit the individual's taste. For these the fondant is melted just as for dipping—namely, in rather small quantities in a shallow pan over hot water—and is flavored—a drop of oil of wintergreen or pepperment is often used—and colored, if desired. (For a detailed description of melting, flavoring, and coloring, see page 154.) The fondant is then removed from the heat and set near some oiled paper which previously has been spread over an even surface. A teaspoon is filled about half full of the melted fondant—the amount depending upon the size desired for the finished mint—and then the fondant allowed to run from it onto the paper. If the candy is of the right consistency, it will slowly spread out into a disc about the size of a 25-cent piece. When most of the fondant has left the spoon, a thread may extend between the mint and the spoon. This may be broken by winding it into a pattern on top of the candy. As soon as one mint is finished, another should be made. After several have been completed, the spoon will be coated with a thick layer of hard fondant. This should be scraped off into another dish and the dropping continued as before.

CHOCOLATE FUDGE

Yield

One and one-quarter pounds, or 25 pieces $1\frac{1}{4}$ inches by 1 inch by $\frac{3}{4}$ inch.

Utensils

Cooking pan: capacity, 3 quarts.

Molding pan:[1] capacity, 1 quart. The one used in this laboratory is $6\frac{1}{2}$ inches by 5 inches by $1\frac{3}{4}$ inches.

[1] For lack of a better term, we are designating the pan in which the finished candy is cooled as the "molding pan."

Proportion of ingredients

	WEIGHT IN GRAMS	APPROXIMATE MEASURE
Bitter chocolate	57.0	2 squares
Sugar	400.0	2 cups
Corn sirup	10.0	2 teaspoons
Coffee cream (18 per cent)[1]	239.0	1 cup
Salt		$\frac{1}{4}$ teaspoon
Vanilla		$\frac{1}{2}$ teaspoon

Order of work

1. Combine the ingredients as follows:
   a) Place the chocolate in the cooking pan, and set this pan inside another containing hot water until the chocolate has melted.
   b) Mix the sugar thoroughly with the melted chocolate; then add the corn sirup and the cream and stir until all are well combined.
2. Bring the sirup slowly to the boiling-point, stirring most of the time. Cook to the soft-ball stage (112° C. [234° F.]). (For description of test, see page 145.) At first, stir the mixture occasionally; toward the end, stir it more often to keep it from sticking to the pan.
3. As soon as the soft-ball stage has been reached, remove the sirup from the fire and set it aside to cool. Cool to 65° C. (149° F.)[2] or until the bottom of the pan feels quite warm but not uncomfortably hot.
4. Oil the molding pan with butter.
5. Beat the candy sirup until it loses its shiny, sticky, appearance and becomes soft and creamy; then continue the beating for a few seconds longer. At the first sign of stiffening, turn it quickly into the molding pan. If turned out at the right instant, it spreads easily over the pan and quickly stiffens with a glossy, slightly roughened surface.

[1] One-half cup evaporated milk plus $\frac{1}{2}$ cup water plus 2 tablespoons butter may be substituted for the cream.

[2] Fudge mixtures, with their large proportion of foreign material, need not be cooled below 65° C. for fine crystals.

If turned out too soon, while still soft and runny, it hardens slowly and is coarse and crystalline. On the other hand, if not turned out until it hardens, it must be kneaded before it can be molded, and as a result has a dull and unattractive surface.

6. Cut the candy when it is cool. Keep it in a tin box tightly covered or in some other practically air-tight container.

BROWN-SUGAR FUDGE

Yield

One and one-quarter pounds, or 25 pieces $1\frac{1}{4}$ inches by 1 inch by $\frac{3}{4}$ inch.

Utensils

Cooking pan: capacity, 3 quarts.

Molding pan: capacity, 1 quart. The one used in this laboratory is $6\frac{1}{2}$ inches by 5 inches by $1\frac{3}{4}$ inches.

Proportion of ingredients

	WEIGHT IN GRAMS	APPROXIMATE MEASURE
Light-brown sugar	195	1 cup
Granulated sugar	200	1 cup
Coffee cream (18 per cent)	239	1 cup

Order of work

1. Weigh or measure the ingredients; mix them together in the cooking pan.
2. Bring the sirup slowly to the boiling-point, stirring most of the time. Cook to the soft-ball stage (112° C. [234° F.]). (For description of test, see page 145.) Regulate the fire so that the cooking-period takes about 20 minutes. At first, stir the mixture occasionally; toward the end, stir it more often to keep it from sticking to the pan.
3. As soon as the soft-ball stage has been reached, remove the sirup from the fire and set it aside to cool. Cool to 65° C. (149° F.), or until the bottom of the pan feels quite warm but not uncomfortably hot.

4. Oil the molding pan with butter.
5. Beat the candy sirup until it loses its shiny, sticky appearance and becomes soft and creamy; then continue the beating for a few seconds longer. At the first sign of stiffening, turn it quickly into the molding pan. If turned out at the right instant, it spreads easily over the pan and quickly stiffens with a glossy, slightly roughened surface. If turned out too soon, while still soft and runny, it hardens slowly and is coarse and crystalline. On the other hand, if not turned out until it hardens it must be kneaded before it can be molded, and as a result has a dull and unattractive surface.
6. Cut the candy when it is cool. Keep it in a tin box tightly covered or in some other practically air-tight container.

PLAIN CARAMELS

Yield

One and one-fourth pounds, or 40 pieces 1 inch by $\frac{3}{4}$ inch by $\frac{3}{4}$ inch.

Utensils

Cooking pan: capacity, 3 quarts.

Molding pan: capacity, 1 quart. The one used in this laboratory is $6\frac{1}{2}$ inches by 5 inches by $1\frac{3}{4}$ inches.

Proportion of ingredients

	WEIGHT IN GRAMS	APPROXIMATE MEASURE
Sugar	200	1 cup
Corn sirup	240	1 cup
Coffee cream (18 per cent)[1]	239	1 cup
Butter	53	$\frac{1}{4}$ cup

Order of work

1. Oil the molding pan with butter.
2. Weigh or measure the ingredients; place them in the cooking pan and mix them well.

[1] One cup of evaporated milk may be substituted for the cream.

3. Cook until a portion separates into strings which are hard but not brittle when poured into cold water (117° C. [242° F.]). Stir occasionally at the beginning of the cooking-period, and constantly after the mixture begins to caramelize.
4. Turn into the molding pan. When entirely cold, remove from the pan, cut into pieces, and wrap each piece in *heavy* waxed paper. (Light-weight paper cannot be removed from caramels easily.)

CHOCOLATE CARAMELS

Follow the recipe for plain caramels with the following change:

1. Add 1 square of bitter chocolate, unmelted, to the hot candy mixture.

CHAPTER IX

ICE-CREAM

All types of ice-cream are crystalline products; and in them, as in candies, crystals of very small size are desired when the cream is served, whether that be shortly after it is made or several hours later. In candies the crystals are made up of sugar particles, in ice-cream they are simply frozen water or ice; nevertheless, the principle of making and keeping them small is the same for the two products. Both contain certain substances which, by acting as interference, keep sugar particles in one case, water particles in the other, from coming together freely to form large crystals, and prevent the growth of such crystals as do form.

The interfering substances in ice-cream are the fat and other milk solids, the sugar and whatever else is added in the way of eggs, fruit, or what not—in fact, everything save water itself, of which there is about 60 to 70 per cent. The most effective interfering substances are those which increase the viscosity of the mixture and thus allow much air to be beaten into it. Beating air into a viscous ice-cream mixture has the same effect as beating it into egg white. In the process many tiny air compartments are formed, each separated from its neighbor by a thin wall made up of water containing solids in solution and suspension. When freezing occurs, the water separates out in crystals which are small at first and stay small apparently owing to the fact that they are protected from each other by the intervening solids and air cells.

One way to obtain a viscous ice-cream mixture is to use a cream of high fat content. This makes the crystals small, but at the same time gives the cream an unpleasant consistency manifested by a tendency to stick to the mouth. In so far as our experience goes, we have found it more satisfactory to use a cream-milk mixture of medium fat content and to bring the viscosity up to the desired point by such substances as eggs, fruit juice, or

gelatin. In adding fruit juice, special precaution must be taken to have the mixture cold, for otherwise the acid will cause the formation of hard curds, like those of cottage cheese, in place of the slight thickening desired. Gelatin should be used in very small quantities, for large ones give a spongy, undesirable texture and a disagreeable flavor.

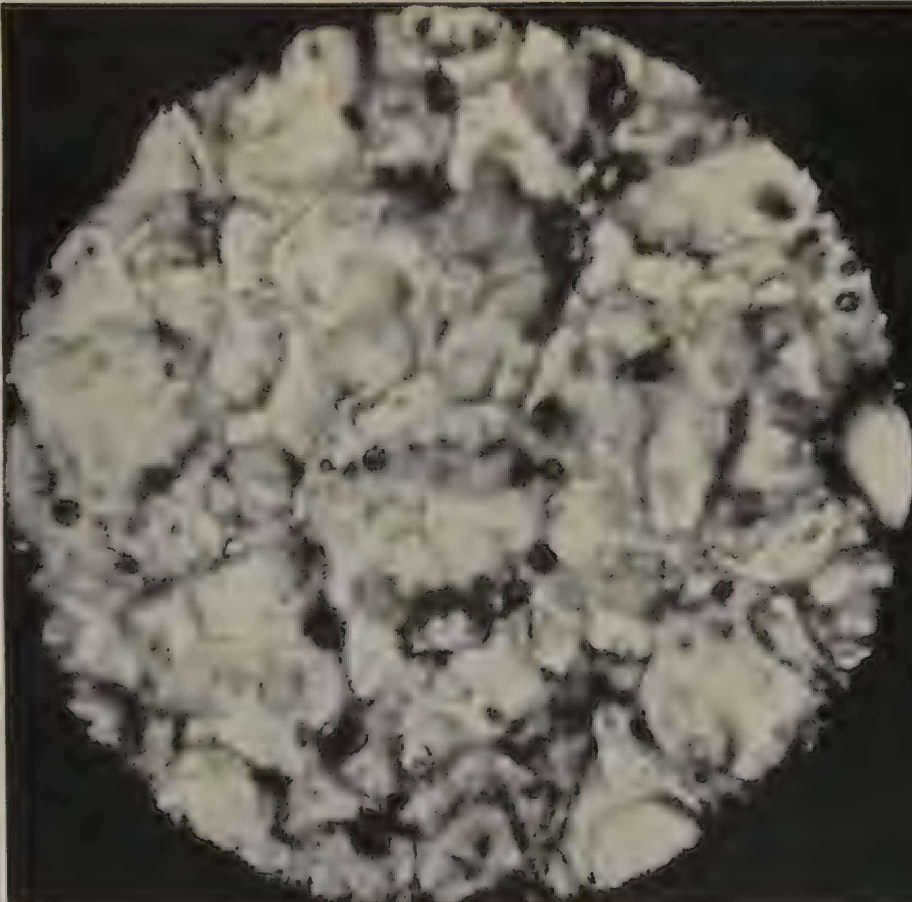
Another way to increase viscosity is to homogenize the cream and milk used; in other words, subject them to a very high pressure so that each large particle of fat is divided into something like 1,000 smaller ones. This process is, of course, not resorted to in the home; but one can take advantage of it by using evaporated milk which is homogenized in the process of manufacture.

Proof that three of the substances just mentioned—egg, gelatin, and evaporated (homogenized) milk—do really tend to make ice crystals small is given by the photomicrographs of Figures 37–40. These were kindly supplied by Meta Given, a former student in this department, now director of the home economics service of the Evaporated Milk Association. Figure 37 shows the ice crystals formed in the control—an ice-cream made from milk, cream, and sugar only. Figures 38, 39, and 40 show the crystals in creams made by substituting egg, gelatin, or evaporated milk for part of the milk and cream used in the control (Fig. 37). Even a casual glance at these photomicrographs shows that the crystals of the ice-creams containing egg, gelatin, or evaporated milk, are, on the average, considerably smaller than are the crystals of the control. It is interesting to know that the viscosities as determined by the Mojonnier milk viscosimeter were alike for the three creams containing egg, gelatin, and evaporated milk, and were appreciably higher than that of the control.

The formulas for the four ice-creams are as follows:

The control (Fig. 37)

Sugar................	14.0 per cent
Cream...............	32.0 per cent
Milk..................	54.0 per cent
	100.0 per cent



Courtesy of the Evaporated Milk Association

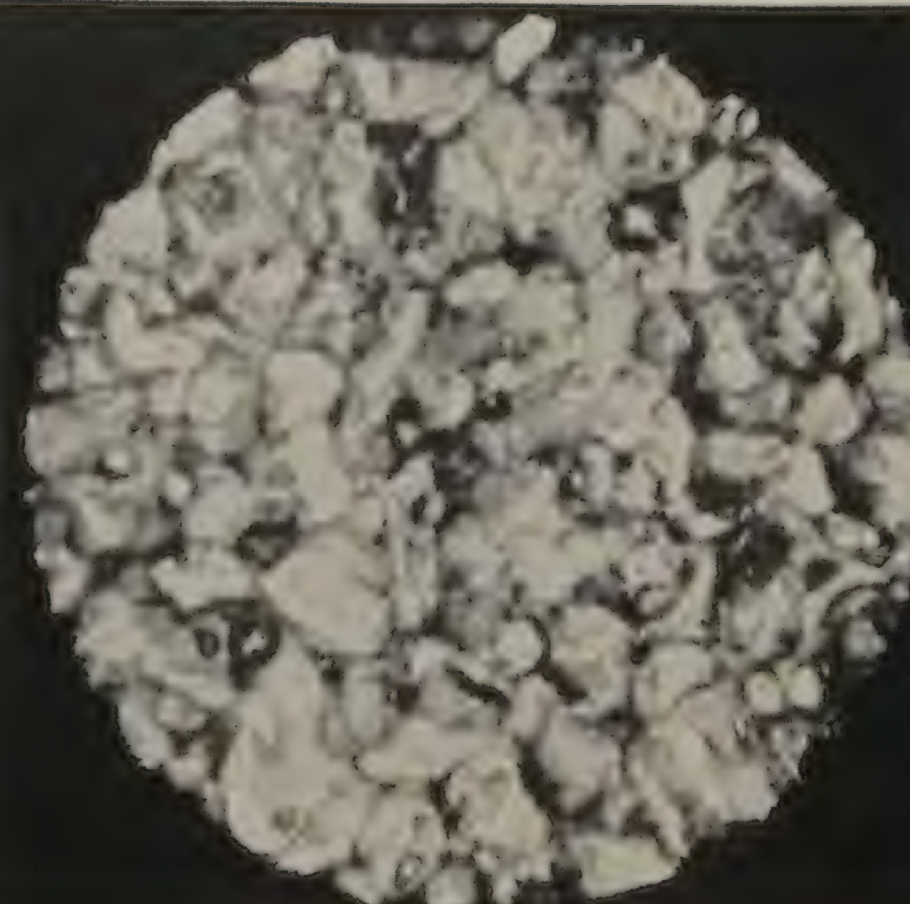
FIG. 37.—Crystals in ice-cream made from cream and milk. Large crystals like these make an ice-cream feel very rough, rather than smooth and velvety to the tongue and also make it appear "watery" rather than rich. Magnification approximately ×200.

Courtesy of the Evaporated Milk Association

FIG. 38.—Crystals in ice-cream made from cream, milk, and *egg*. These crystals are smaller than those in Figure 37 and give to the ice-cream a more velvety texture. Magnification approximately ×200.

Courtesy of the Evaporated Milk Association

FIG. 39.—Crystals in ice-cream made from cream, milk, and *gelatin*. Magnification approximately ×200.



Courtesy of the Evaporated Milk Association

FIG. 40.—Crystals in ice-cream made from cream, milk, and *evaporated (homogenized) milk*. Magnification approximately ×200.

The crystals in these two figures, like those in Figure 38, are much smaller than the ones in Figure 37 and form a velvety ice-cream.

The ice-cream containing *egg* (Fig. 38).

Sugar	14.0 per cent
Cream	31.0 per cent
Milk	52.0 per cent
Egg	2.5 per cent
	100.0 per cent

The ice-cream containing *gelatin* (Fig. 39)

Sugar	14.0 per cent
Cream	32.0 per cent
Milk	53.0 per cent
Gelatin	00.3 per cent
	100.0 per cent

The ice-cream containing *evaporated* (*homogenized*) *milk* (Fig. 40)

Sugar	14.0 per cent
Cream	28.0 per cent
Milk	36.0 per cent
Evaporated milk	22.0 per cent
	100.0 per cent

For a given viscosity the amount of air beaten into an ice-cream mixture is dependent upon the speed of turning the freezer and also upon the temperature of the surrounding bath. The latter, in turn, is largely determined by the proportion of salt to ice. If much salt is used—say one part to three or four of ice by measure—the temperature runs down rapidly, and as a consequence the time through which the freezer can be turned is short. Therefore, it is difficult to turn a freezer by hand fast enough to incorporate sufficient air for a fine-textured ice-cream. We have had very good results by using one part salt to six of ice by weight, which by measure is about one to twelve, or 1 cup salt to each 3 quarts of chopped ice.

DIRECTIONS FOR THE PREPARATION OF ICE-CREAM[1]

Yield for each recipe

Eleven servings of ½ cup each.

[1] Measurement of the ingredients used in ice-cream will give proportions sufficiently accurate for home cooking.

Utensils

A 2-quart ice-cream freezer which has a beater. (For method of putting the parts together, see the booklet of instructions that accompanies the freezer.)

A burlap ice bag about 16 inches square and a mallet with a head at least 6 inches long and with a handle 9 to 10 inches long; or an ice chipper.

Ice and salt

Ten to 11 pounds (8 to 9 quarts) of chopped ice and about $\frac{1}{2}$ pound ($2\frac{1}{3}$ to $2\frac{2}{3}$ cups) of ice-cream salt are the minimum quantities required to freeze and pack (once) a 2-quart freezer of ice-cream on a cool day, about 75° Fahrenheit, when there are no delays between the time the ice is chopped and the cream packed.

VANILLA ICE-CREAM (WITH EGG)

Proportion of ingredients

	WEIGHT IN GRAMS	APPROXIMATE MEASURE
Egg	48.0	1 medium sized
Sugar	100.0	$\frac{1}{2}$ cup
Milk	305.0	$1\frac{1}{4}$ cups
Coffee cream (18 per cent)	597.5	$2\frac{1}{2}$ cups
Vanilla		$1\frac{1}{2}$ teaspoons
Salt		$\frac{1}{2}$ teaspoon

Order of work: detailed form

1. Pour boiling water over the cream can and the beater of the freezer; drain them, and set them aside to cool.

   Select a cork which fits the opening in the top of the can, if a tight packing cover is not available.

2. From the egg, sugar, and milk prepare a custard as follows:
   a) Beat the egg until the yolk and white are well mixed. Weigh or measure the sugar and milk. Stir them with the egg. Transfer to the top of a double boiler.
   b) Cook the mixture in the double boiler, stirring constantly, until it thickens enough to coat a metal spoon with a thin layer that will not drain off (about 4 minutes). Then set it in a pan of cold water.

The custard is very thin, being but slightly thicker than coffee cream. Care should be taken to avoid overcooking it, for heating a little too long will cause the formation of small curds which can be detected in the finished ice-cream.

3. While the custard is cooling, place near the freezer a large pan in which the ice and salt can be mixed; a quart measure and a cup in which the ice and salt, respectively, can be measured. Lastly, crush the ice into small pieces.
4. Mix the cream, vanilla, and salt with the cooled custard; then pour this mixture into the cream can of the freezer and fit the dasher, lid, can, and crank into place.

   If the parts are fitted together correctly, the crank will turn freely, and the dasher as well as the cream can will revolve when the crank is turned.
5. Freeze the ice-cream as follows:
   a) Measure 4 quarts of the chopped ice; add $1\frac{1}{3}$ cups of the salt. Mix the two, and quickly pack them into the ice chamber of the freezer.

   b) Turn the crank slowly[1] for about 3 minutes, then as quickly as possible until it is very difficult to turn (about 6 minutes more).

   If the finished ice-cream is to be at its best, the turning must be continuous.

   c) Clear away the salt and ice to about 1 inch below the bottom of the lid of the cream can, and wipe the lid carefully to remove the brine. Open the can, remove the beater, and pack the ice-cream into the bottom of the can.

   When the cream is packed, it should be frozen almost, but not quite, solid enough to serve.

   d) Replace the lid of the can and fit it with the cork or packing-cover, to prevent the brine from entering through the hole.
6. Pack the ice-cream as follows:

[1] Slow turning means about 40 revolutions per minute; fast turning about 140 revolutions per minute at first, and 80 at last when the cream is almost frozen.

a) Drain most of the water from the ice chamber. Mix together 3 quarts more of the chopped ice and 1 cup of the salt. Quickly pack them into the freezer, being sure to place a layer over the can.

b) Cover the freezer with paper and a damp cloth. Set it in the coolest place available until ready to serve.

At the end of an hour or so, examine the ice chamber, and, if necessary, drain free from water and repack with a fresh ice-salt mixture.

Order of work: Abbreviated form

1. Proportion of ingredients

Egg	1 medium sized
Sugar	$\frac{1}{2}$ cup
Milk	$1\frac{1}{4}$ cups
Coffee cream (18 per cent)	$2\frac{1}{2}$ cups
Vanilla	$1\frac{1}{2}$ teaspoons
Salt	$\frac{1}{2}$ teaspoon

2. Mix together the beaten egg, sugar, and milk. Cook them in a double boiler until they form a coating on a metal spoon. When cool, mix them with the cream, vanilla, and salt and turn them into the cream can of the freezer.
3. Fit the parts of the freezer together.
4. Pack the ice chamber (4 quarts of ice plus $1\frac{1}{3}$ cups of salt).
5. Turn the crank slowly for 3 minutes, then rapidly until it becomes very difficult to turn (about 6 minutes).
6. Remove the beater. Pack the ice chamber (3 quarts ice plus 1 cup salt).

VANILLA ICE-CREAM (WITH GELATIN)

Proportion of ingredients

	WEIGHT IN GRAMS	APPROXIMATE MEASURE
Gelatin	5.0	$1\frac{3}{4}$ teaspoons
Cold water		1 tablespoon
Boiling water		1 tablespoon
Milk	305.0	$1\frac{1}{4}$ cups

Proportion of ingredients—*Continued*

	WEIGHT IN GRAMS	APPROXIMATE MEASURE
Sugar..................	100.0	½ cup
Coffee cream (18 per cent)	597.5	2½ cups
Salt...........................		½ teaspoon
Vanilla........................		2 teaspoons

Order of work

1. Pour boiling water over the cream can and the beater of the freezer; drain them and set them aside to cool.

   Select a cork which fits the opening in the top of the can, if a tight packing cover is not available.

2. Dissolve the gelatin and sugar as follows:
   a) Weigh or measure the gelatin. Mix the cold water with it and let the two stand for about 5 minutes.
   b) Weigh or measure the milk and sugar. Mix them, then heat over hot water.
   c) Add the boiling water to the gelatin and stir the two together over hot water until all of the gelatin is dissolved. (Granules of undissolved gelatin can be detected in the finished ice-cream.)

      Add the gelatin to the warm milk-sugar mixture and continue heating until all of the sugar and gelatin are dissolved, then cool.

3. While the milk-gelatin-sugar mixture is cooling, place near the freezer a large pan in which the ice and salt can be mixed; a quart measure and a cup in which the ice and salt, respectively, can be measured. Lastly, crush the ice into small pieces.

4. Mix the cream, vanilla, and salt with the cooled milk-gelatin-sugar; then pour this mixture into the cream can of the freezer, and fit the dasher, lid, can, and crank into place.

   If the parts are fitted together correctly, the crank will turn freely and the dasher as well as the cream can will revolve when the crank is turned.

5. Freeze the ice-cream as follows:

a) Measure 4 quarts of the chopped ice; add $1\frac{1}{3}$ cups of the salt. Mix the two and quickly pack them into the ice chamber of the freezer.

b) Turn the crank slowly[1] for about 3 minutes, then as quickly as possible until it is very difficult to turn (about 6 minutes more).

If the finished ice-cream is to be at its best, the turning must be continuous.

c) Clear away the salt and ice to about 1 inch below the bottom of the lid of the cream can and wipe the lid carefully to remove the brine. Open the can, remove the beater, and pack the ice-cream into the bottom of the can.

When the cream is packed, it should be frozen almost, but not quite, solid enough to serve.

d) Replace the lid of the can and fit it with a cork or packing-cover to prevent brine from entering through the hole.

6. Pack the ice-cream as follows:

a) Drain most of the water from the ice chamber. Mix together 3 quarts more of the chopped ice and 1 cup of the salt. Quickly pack them into the freezer, being sure to place a layer over the can.

b) Cover the freezer with paper and a damp cloth. Set it in the coolest place available until ready to serve.

At the end of an hour or so, the ice chamber should be examined, and, if necessary, drained free from water and repacked with a fresh ice-salt mixture.

STRAWBERRY ICE-CREAM

Proportion of ingredients

	WEIGHT IN GRAMS	APPROXIMATE MEASURE
Fresh strawberry juice....	390.0	$1\frac{1}{2}$ cups (the juice from about 1 quart of fresh, ripe berries)

[1] See footnote on page 167.

Proportion of ingredients—*Continued*

	WEIGHT IN GRAMS	APPROXIMATE MEASURE
Lemon juice.............	15.3	1 tablespoon (juice from about $\frac{1}{2}$ lemon)
Milk...................	183.0	$\frac{3}{4}$ cup
Sugar............	200.0 to 300.0	1 to $1\frac{1}{2}$ cups
Coffee cream (18 per cent)[1]	358.5	$1\frac{1}{2}$ cups
Salt...........................		$\frac{1}{4}$ teaspoon

Order of work

1. Pour boiling water over the cream can and the beater of the freezer; drain them and set them aside to cool.

   Select a cork which fits the opening in the top of the can, if a tight packing cover is not available.

2. Wash and stem the berries. Mash them to a pulp with a potato-masher. Press as much of the juice and pulp through a coarse sieve as will go without carrying seeds with it.

   Weigh or measure from this juice the amount needed, add the lemon juice to it, and set the mixture in a cool place.

3. Weigh or measure the milk and sugar. Mix the two and heat them over hot water until the sugar is dissolved. Then cool.

4. While the sugar-milk mixture is cooling, place near the freezer a large pan in which the ice and salt can be mixed, a quart measure and a cup in which the ice and salt, respectively, can be measured. Lastly, crush the ice into small pieces.

5. Mix the cream and salt with the cool milk-sugar solution; turn this mixture into the cream can of the freezer and fit the beater, lid, can, and crank into place.

   If the parts are fitted together correctly, the crank will turn freely and the beater as well as the cream can will revolve when the crank is turned.

[1] Evaporated milk may be substituted for the cream.

6. Freeze the ice-cream as follows:
   a) Measure 4 quarts of the chopped ice; add $1\frac{1}{3}$ cups of the salt. Mix the two, and quickly pack them into the ice chamber of the freezer.
   b) Turn the crank slowly[1] until the mixture is frozen to a soft mush (for about 7 minutes).
   c) Clear away the salt and ice to about 1 inch below the bottom of the lid of the cream can and wipe the lid carefully to remove the brine.
   d) Open the can and mix the strawberry and lemon juice with the cream; then, as quickly as possible, replace the parts of the freezer, mix another quart of the ice with $\frac{1}{3}$ cup of the salt, pack into the ice chamber, and start turning the crank.
   e) Turn the crank slowly for about 1 minute, then as rapidly as possible until it becomes very difficult to turn (about 6 minutes more).

      If the finished ice-cream is to be at its best, the turning must be continuous except for the short break during the addition of the fruit juice, which should not take longer than about 2 minutes.
   f) Open the cream can, taking the same precautions as above to prevent brine from entering it; remove the beater; and pack the ice-cream into the bottom of the can.

      When the cream is packed, it should be frozen almost, but not quite, solid enough to serve.
   g) Replace the lid of the can and fit it with the cork or packing cover to prevent brine from entering through the hole.
7. Pack the ice-cream as follows:
   a) Drain most of the water from the ice chamber. Mix together 3 quarts of the chopped ice and 1 cup of the salt. Quickly pack them into the freezer, being sure to place a layer over the can.

[1] See footnote on page 167.

b) Cover the freezer with paper and a damp cloth. Set it in the coolest place available until ready to serve.

At the end of an hour or so, examine the ice chamber, and, if necessary, drain free from water and repack with a fresh ice-salt mixture.

ORANGE ICE-CREAM

Proportion of ingredients

	WEIGHT IN GRAMS	APPROXIMATE MEASURE
Orange juice	367.0	$1\frac{1}{2}$ cups (juice from about 4 juicy oranges)
Lemon juice	61.0	$\frac{1}{4}$ cup (juice from about 2 lemons)
Milk	183.0	$\frac{3}{4}$ cup
Sugar	250.0	$1\frac{1}{4}$ cups
Coffee cream (18 per cent)	358.5	$1\frac{1}{2}$ cups
Salt		$\frac{1}{4}$ teaspoon

Order of work

1. Pour boiling water over the cream can and the beater of the freezer; drain them and set them aside to cool.

   Select a cork which fits the opening in the top of the can, if a tight packing cover is not available.
2. Squeeze out the orange and lemon juice. Strain each through a coarse sieve, then weigh or measure, mix, and set aside in a cool place.
3. Weigh or measure the milk and sugar. Mix the two and heat them over hot water until the sugar is dissolved, then cool.
4. While the sugar-milk mixture is cooling, place near the freezer a large pan in which the ice and salt can be mixed, a quart measure and a cup in which the ice and salt, respectively, can be measured. Lastly, crush the ice into small pieces.

5. Mix the cream and salt with the cool milk-sugar solution; turn this mixture into the cream can of the freezer; and fit the beater, lid, can, and crank into place.

   If the parts are fitted together correctly, the crank will turn freely and the beater as well as the cream can will revolve when the crank is turned.

6. Freeze the ice-cream as follows:
   a) Measure 4 quarts of the chopped ice; add $1\frac{1}{3}$ cups of the salt. Mix the two and quickly pack them into the ice chamber of the freezer.
   b) Turn the crank slowly[1] until the mixture is frozen to a soft mush (for about 7 minutes).
   c) Clear away the salt and ice to about 1 inch below the bottom of the lid of the cream can and wipe the lid carefully to remove the brine.
   d) Open the can and mix the fruit juice with the cream; then, as quickly as possible, replace the parts of the freezer, mix another quart of ice with $\frac{1}{3}$ cup salt, pack into the ice chamber, and start turning the crank.
   e) Turn the crank slowly for about 1 minute, then as rapidly as possible until it becomes very difficult to turn (about 6 minutes more).

      If the finished ice-cream is to be at its best, the turning must be continuous except for the short break during the addition of the fruit juice, which should not take longer than about 2 minutes.

   f) Open the cream can, taking the same precautions as above to prevent brine from entering it, remove the beater, and pack the ice-cream into the bottom of the can.

      When the cream is packed, it should be frozen almost, but not quite, solid enough to serve.

   g) Replace the lid of the can, now fitted with a cork, to prevent brine from entering through the hole.

7. Pack the ice-cream as follows:

[1] See footnote on page 167

a) Drain most of the water from the ice chamber. Mix together 3 quarts of the chopped ice and 1 cup of the salt. Quickly pack them into the freezer, being sure to place a layer over the can.

b) Cover the freezer with paper and a damp cloth. Set it in the coolest place available until ready to serve.

At the end of an hour or so, examine the ice chamber, and, if necessary, drain free from water and repack with a fresh ice-salt mixture.

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HOWS AND WHYS of COOKING

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